ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 64. No. 8. 220 Broadway, New York, August 25, 1910.

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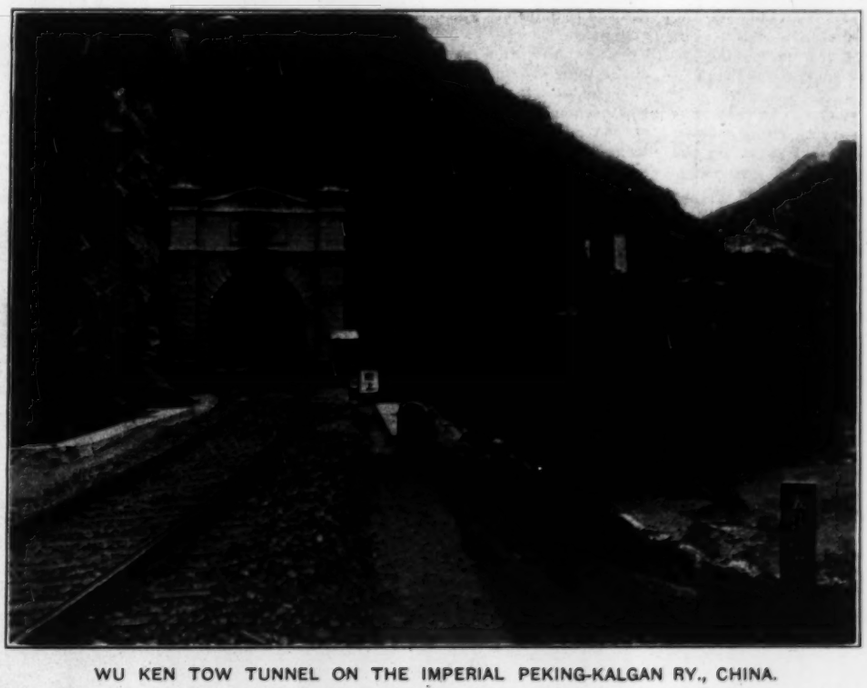
The Imperial Peking-Kalgan Railway and Its Extension.*

By J. L. DOBBINS.†

At a time when diplomatic interests in China are deeply involved in the settlement of the Chinchou-Aigun railroad controversy, and while discussions of the feasibility of that project are still frequent, an excellent opportunity is afforded to admire the quiet and steady way in which preparation has been made and construction work well commenced by the Chinese on the western extension of the Peking-Kalgan railroad.

There is no better example in China of complete and successful construction and operation of an independent railway system, entirely under Chinese supervision and management, than the Peking-Kalgan line; and this present extension, exceeding in length the original line, is being undertaken under the same administration. It will reach out westward from Kalganinto in an agriculturally productive country, which even now has large exports of wool and hides over the present overland caravan routes; and it will also be of great importance in the future operation of the railroad, by tapping the great coal fields of northern Shansi, thereby making this railroad independent in its coal supply, freeing it from the long haul of its present supply over the Imperial Railways of North China.

A glance at the accompanying map (Fig. 2) shows also the strategic importance of the line joining Western Mongolia and Shansi with the already constructed line between Peking and Mongolia. And at the time when the representatives of other nations are urging the relative merits of the Chinchou-Aigun route or the Russian alternative project of a line joining Kalgan and the Trans-Siberian railroad by way of Urga and Kiatcha, China has diplomatically taken its own means of strengthening its position in this western territory by constructing a railroad entirely within its own control. This extension, too, forms a link in the possible later connection with the Trans-Siberian line which will always be much more independently in Chinese control than would be possible with the suggested Kalgan-Kiatcha route.



WU KEN TOW TUNNEL ON THE IMPERIAL PEKING-KALGAN RY., CHINA.

(The black faced post with the white letters shows the number of the bridge, the far white post with black letters the mileage, or in the measurement of the country the "liage," and the near white post with the black letters the grade.)

The Peking-Kalgan line was projected and built by the Chinese Government quite without any foreign loan or bond issue, having been financed entirely from the earnings of the Imperial Railways of North China, and the funds for the extension are to be provided in the same way, for which purpose will be available both the revenue from the Imperial Railways, and also that from the present Peking-Kalgan line when that line has brought its operations up to a profit paying basis. Although this line has been in operation for some months, having been opened to traffic late in 1909, this operation was commenced in some places over temporary structures, and the present earnings of the line are now being utilized in the final completion of the roadbed.

As both the location and construction of this road, as well as its financing, were entirely in Chinese hands, it affords an excellent basis for comparison to similar work done in China under foreign administration, and the following description of the physical features of the line and of its engineering difficulties will serve to make such a comparison clear.

Starting from its connection with the Imperial Railways of North China at Fengtai, this line touches Peking at the Hsichimen, or West Gate, just outside the Peking wall, and continues northwest along the level plain that forms the eastern half of the province of Chihili, for a distance of 34 miles starting to rise at a 1% grade just before reaching Nankou. Here the line turns abruptly northward and enters the Nankou Pass in which it reaches a summit at an elevation of about 2,100 ft.

It is in this eleven miles of the road that the thoroughness of the construction is most evident. The Nankou Pass is narrow and steep, with the bottom entirely taken up by a river which is but a small stream during the spring months but which shows high water marks as evidence of its high flood stages during the wet months of July, August and September. Because of the small width of the canyon and the abrupt steepness of its sides, the grade of the road follows that of the stream very closely, and the maximum grade of 3.33% is necessitated by the rapid rise of the bed of the stream. Throughout the pass, the subgrade level is at no place less than 20 ft. above the bed of the stream, and the entire embankment is riprapped on the stream side wherever it is not separated from the channel of the stream by a mass of bed rock or by boulders already in place. As soon as the masonry culverts and other waterways were finished, and the cuts and embankments com-

*The photographs accompanying this article were sent us independently of Prof. Dobbins, by Mr. C. L. Chai, District Engineer of the Peking-Kalgan Railway Extension, but they so aptly illustrated Mr. Dobbins' article that we have included them therein.

Other short articles on this railway have appeared in Eng. News, Jan. 9, 1908, p. 34, and March 5, 1908, p. 264.—Ed.]

†Professor of Civil Engineering, Imperial Pei Yang University, Tientsin, China.

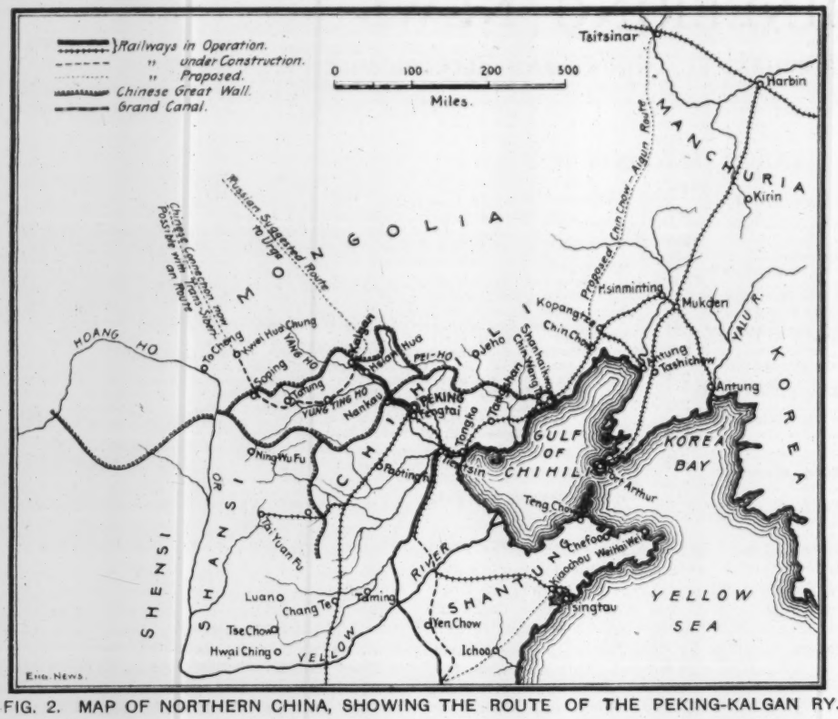


FIG. 2. MAP OF NORTHERN CHINA, SHOWING THE ROUTE OF THE PEKING-KALGAN RY.

pleted, the track steel was laid and the road prepared for immediate operation. The unfinished state of the final rock surfacing of the stream side of the embankments was not considered a sufficient cause to delay the commencement of operation, and that part of the work is now being finished.

The standard width of roadbed on embankments is a graduated one, varying from a 20-ft. width on shallow embankments to 23 ft. on the highest fills. Wherever rock facing was necessary, the earth embankment has been first built up to its full 23 ft. top width, and outside of this the rock facing extends for an additional horizontal width of 3 ft. at the top of the embankment. The width of this facing at the base varies with the height of the embankment, increasing about 1 ft. for each 10 ft. vertical, so that a 60-ft. fill has a prism of rock protection whose horizontal base width is about 9 ft. which tapers to 3 ft. at the top, and which extends at uniform surface slope from about 4 ft. below the surface of the ground at the base up to subgrade level.

The facing of this work is built up of rocks of from 1 to 3 cu. ft. content, the size being limited to the load that eight men can handle with slings and carry down the slope. The backing is composed of spalls and stones of a minimum weight of about 20 lbs., the entire wall being laid by hand, each rock being securely and firmly placed, and the surface finished up to an even slope. All small waterways are of concrete or of squared sandstone or limestone, laid in Portland cement mortar; and on the downstream side of these waterways the rock facing is also laid in cement mortar for a distance of 15 to 20 ft.

This facing is in every case continued up to subgrade, even where that is 30 to 40 ft. above high water level—an expensive mode of construction that could hardly be justified on a similarly situated American road, where the damage or delay due to a possible washout would occasion a less expense than the capitalized value of the original cost of such construction.

But in this case two valid reasons exist to warrant the course which has been followed. One, the strategic reason, is that the Peking-Kalgan Ry. is the one connecting link between the capital of the Empire and Mongolia, and any washout in the Nankow Pass, sufficient to hold up railroad traffic, would also in all probability flood or wash out the cart road which occupies the same pass and which is the one other main line of travel between these two parts of the Empire. Such a washout would require time and heavy new rockwork to make it even passable again, with a complete blockade of traffic during the progress of the reconstruction, hence the greater need to anticipate such a possibility. Furthermore, the wash on earth embankments, caused merely by the direct rainfall, can be extremely heavy, owing to the severe cloudbursts to which this country is subject, rates of precipitation as high as 0.9-in. per hr., for short intervals, having been recorded within the eight years.

An investigation into the construction furnishes the other and deciding explanation this thorough mode of construction.

In Chinese earthwork measurement, the of volume is the fang, consisting of 100 cu Chinese measurement,* or the equivalent of cu. yds. The contract price of this stone in place varied on the work in the Nankou from $0.80 to $2, local currency, per fang, according to the size of the rock. This is equivalent in gold coin, at present rates of exchange, of 8.1 to 20.2 cts. per cu. yd. The corresponding costs for earth and rock excavation and bankment in this division varied from $0.20 to $1.20 local currency per fang, or from 1.9 to 11.4 cts. gold per cu. yd.; while on the short branch line of 16 miles from the Hsichimen station to Mentoukou, 100,000 fang of earth embankment was contracted at a price of approximately 14 cts. per fang, or less than 1.4 cts. gold per cu. yd. This minimum rate and the low costs throughout for this part of the construction make up one of the features in favor of all Chinese management for such undertakings, whenever possible, for these prices were possible only because of the direct dealings between the Chinese engineers in charge and the Chinese contractors, without recourse to any middlemen or compradors who are the usual go-betweens where the construction is under foreign engineers.

The above prices for stonework include quarrying and blasting, transportation to the spot required and laying up in place. This quarrying is done close to the track, and the rock is carried to the place where it is used by men using poles and slings as their means of transportation. The lower part of the Nankou Pass runs through a formation of altered limestone, the upper part through a reddish sandstone, both of which furnish excellent material for this purpose.

At the mouth of the Nankou Pass, the road enters between two watch towers of the Great

*The Chinese units of measurement differ in the different arts, the foot for land and earthwork measure being the equivalent of 12.5 Eng. ins.

FIG. 3. NATIVE CHINESE ENGINEERS ON THE PEKING-KALGAN RY.

Standing, Assistant Engineers.
Su yi chao, Liu kee, Chao chih, Chang tsun po, Tsai tsun chow, Chang hung kow, Hsii wen chin.

Seated.

Chai chao Lin, (Dist. Eng.)	Chen Hsi Lin, (Ass't. Chf. Eng.)	Jeme Tien Yow, (Chf. Eng.)	Yen Si Ching, (Ass't. Chf. Eng.)	Yii Jen Fong (Dist. Eng.)

FIG. 4. VIEW OF TWO TRAINS ON CHIN LUNG CHIAO Y.

Chinese Wall which are stationed on bluffs commanding the entrance, and the wall itself, as it follows the crests of the ranges bordering the pass, is visible at intervals along the entire route up the canyon, until at the upper end the road crosses directly under the Great Wall, in the 3,570-ft. Pataling tunnel, in which the grade reaches its summit.

In ascending this grade, the road passes through four tunnels, with a total length of 5,370 ft., crosses 54 small waterways on masonry arches (Fig. 7) or culverts of varying dimensions, the largest of which is a skew arch of 40-ft. span and 60-ft. crown height above the bed of the stream; and it passes over one steel span, a deck type, Pratt truss. The maximum grade of this division is 3.33%, and just before reaching the summit one switchback at Ching Lung Chiao is resorted to as a means of making the steep climb. This switchback is admirably situated to conform to the scheme of operation for this Nankou division. For this pass with its high grades, the engines used are 12-driver articulated engines of the Mallet type, and from Nankou up to the switchback at Ching Lung Chiao these engines are coupled to the rear of all passenger trains as pushers. At the switchback the maximum gradient ends, and from there to the summit tunnel and down the other slope of the grade to the division point at Kang Chuang, the engine runs at the head of the train. In this way the necessity of running around the train at any station is obviated, and at the same time is provided the safety precaution of having the engine at the down-grade end of the train on all steep grades.

The present Peking-Kalgan Ry. is 122 miles in length, with a branch line from Peking to Mentoukou, and with one spur from the siding at Hsia Yuan to a small coal mine at Kimingyih which is owned and is being opened up by the railroad.

After leaving the Nankou Pass, the road drops by a gradual grade into the long valley of the Yung Ting Ho which it follows for a distance of about 42 miles, with numerous stream crossings aggregating 2,662 lin. ft. of clear openings, the longest of which is a 10-span deck bridge, 1,000 ft. in length. In the last division, from Hsia Hua Yuan to Kalgan, the road follows for several miles the Yang Ho, which there flows through a narrow tortuous canyon, requiring much heavy earthwork and 151 bridges and culverts in a distance of 34.6 miles.

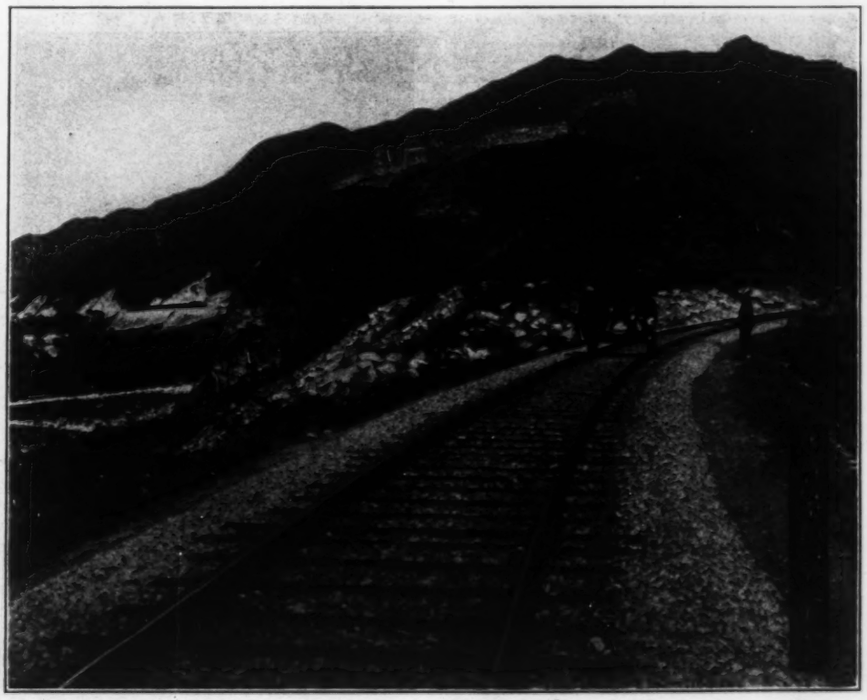


FIG. 5. VIEW ON ONE OF THE STIFF GRADES OF THE PEKING-KALGAN RY. GREAT WALL OF CHINA IN BACKGROUND.

After leaving this river, the road swings around the south slope of majectic peak, Chi Ming Shang, with the walled city of Chi Ming I at its base, and then swerves to the north, rising at an easy grade in its approach to Kalgan. This terminus of the line is situated at the mouth of the

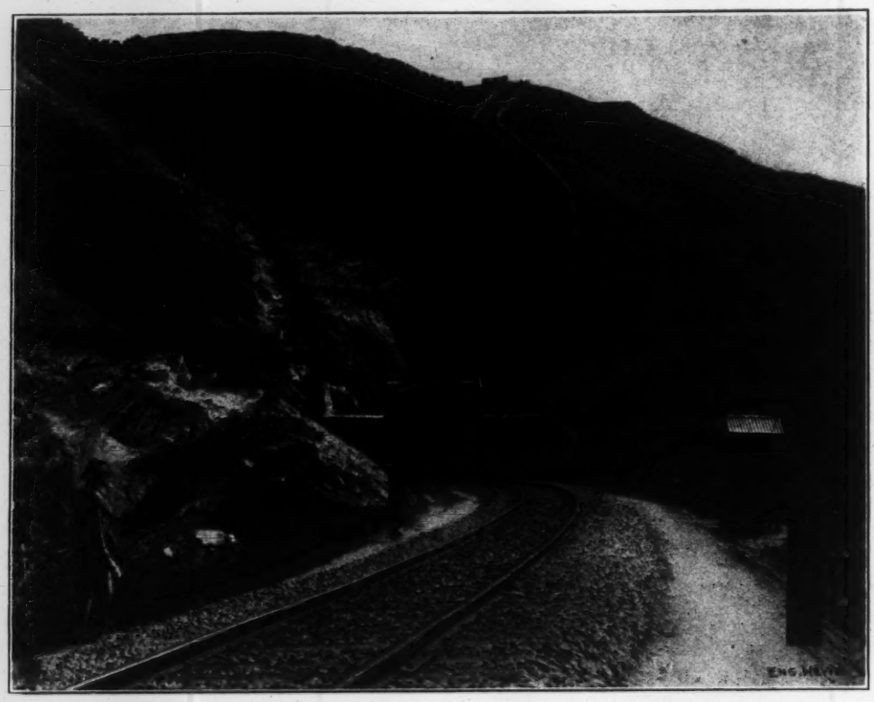


FIG. 6. ENTRANCE TO ONE OF THE TUNNELS, SHOWING GREAT WALL WINDING OVER THE HILL.

Kalgan Pass, which is on the old caravan route between Peking and cities in eastern Russia, and which still is the route of the Russian official mail service to Peking. All the cities touched by the railroad are walled cities, into which the trains cannot enter, and at each of these, as at Kalgan, the railroad station has been located just outside the wall, and has, especially at the last-named terminal, already attracted much of the cities' business to its vicinity.

The present extension will reach westward from Kalgan about 250 miles to Kwei Hua Cheng, which lies north and east from the great northern bend of the Huang Ho, or Yellow River, near the northern boundary of Shansi, and outside the northern branch of the Great Wall. It will follow the course of the Nan Yang Ho as far as Ta Tung Fu and then continue westward through the Huang Hua Range to So Ping Fu and on to its terminus, thus tapping many of the larger coal fields of northern Shansi.

This extension will be under the same able management as was the Peking-Kalgan line, with Taotai Jeme Tien Yu* as Director and Chief Engineer, assisted by a corps of Chinese engineers (Fig. 3).

The entire rolling stock of the railroad, with the exception of its special mountain locomotives already mentioned and the Shay engines used on its spur to Kimingyih, was built for the road in the shops of the Imperial Railways of North China at Tangshan, and the present equipment of the Peking-Kalgan line does not include any shops other than those required for maintenance and quick repair work.

With the single exception of the railroad just completed in Western Yunnan under French concessions and with French engineers, the Peking-Kalgan line traverses the most mountainous route of any railroad yet built in China, and in view of this and the fact that its roadbed fully equals that of any of the others, the following statement of cost figures affords an excellent basis of comparison, and reflects great credit on the administration of this road. The figures as given below include total costs, per mile of main line, of the entire railroad, including roadbed, all stations and other buildings connected with its administration, rolling stock, and all other construction and maintenance equipment. For comparison, the principal line built under concessions of each of the nationalities named has been selected. The figures are taken wherever possible from the reported costs of the original construction. Where these reports have not been available, the estimated cost, obtained from the preliminary reports, has been used.

*Mr. Jeme Tien Yu is a graduate of Yale University, and many of his assistants were educated in America.

TABLE SHOWING RELATIVE COSTS OF CHINESE RAILWAYS.

Railroad.	Engineering management.	Length, miles.	Cost per mile, (U. S. currency).
Imperial Rys. of N'th China	British	588	$41,800
Chinese Eastern	Russian	1,596	90,000
Peking-Hankow	Belgian	760	41,380
Shantung Ry.	German	280	46,000
Yunnan Ry.	French	535	60,000
South Manchurian	Japanese	714	140,000
Peking-Kalgan	Chinese	122	41,000

Temporary Defeat of the Project for a New York State School of Sanitary Science and Public Health.

The need for schools specifically directed to the training of public health officers for service in this country has been urged more than once in these columns. For two years past a course of lectures on public health and sanitary science has been delivered at Cornell University under the cooperation of that institution and the New York State Department of Health. With the idea of establishing this instruction on a more comprehensive and permanent basis, a number of bills were introduced in the 1910 session of the New York Legislature. All of these seem to have contemplated the establishment of a school of sanitary science and public health at Cornell University. The bills were finally consolidated into one, which was passed, but was vetoed by Governor Hughes for reasons stated further on. Before giving the main provisions of the bill, we reprint portions of a circular entitled, "Education in Sanitary Science," issued by the New York State Department of Health some months ago. After calling attention to the fact that of the 140,000 deaths in New York State during 1909, about 25,000 were from preventable diseases and giving some illustrative details designed not only to show this fact but also the great economic loss to the state resulting therefrom, the circular continues as follows:

Realizing the needlessness of such waste of life, the economic loss to the state and the accompanying misery and suffering, and believing that without education of the people all the other efforts of the State Department of Health are bound to result in incomplete success, it argues for more education on public health matters as the most feasible, the quickest and the most effective method of preventing and eliminating this unnecessary mortality.

FIG. 7. TYPICAL SMALL SPAN CONCRETE ARCH, PEKING-KALGAN RY. SHOWING TYPE OF RIP-RAPPING USED ON SUCH STRUCTURES.

Proper Agency for This Educational Work.

It is unquestionably the function of the state, through its Department of Health in other ways, to check this unnecessary loss of life. There exists at present no other agency, either public or private, for instruction in these matters.

The public schools of the state, which so liberally and efficiently train the coming generation for their future citizenship, have omitted entirely this phase of education and spend large sums on each child, which are often wasted only by its premature death from some preventable disease.

Experience shows that the work of the health officer and other health authorities is often vitiated by the resistance and antagonism of the very people whom he would benefit, because of their ignorance. Public indifference to measures obviously needed for protection of public health prevents their adoption.

The medical training of the average physician does not deal with general sanitation and his efficiency as health officer depends on his own energy and persistency in the study that he undertakes as a public benefactor. Lack of appreciation on the part of the public kills his interest and the result is a decreased activity on the part of both health officer and public. [Italics ours.—Ed.] Rouse the people to the point where they will demand protection against preventable disease and the efficiency of public health work would be greatly increased.

Before all the other agencies, as being duly authorized by law to take cognizance of the life and health of the citizens of the state, is the Health Department. This agency cannot have individual dealings with the 8,000,000 people of the state, but must act through the health officers on the one hand and with the cooperation of the citizens on the other. If the citizens of the state are lacking in knowledge of what constitutes public health and measures to secure it, neither the efforts of the State Department nor the suggestions and efforts of the local health officers will be of avail. It is, then, evident that the efforts of the State Department should be expended in these two directions: First, toward the better education and the larger field for the health officer; second, for a better appreciation of his work by the people in general.

Methods to be Adopted.

Adequate channels from which the needed education must come do not at present exist. Except in a small way, the State Department of Health has been able to do but little. Public meetings have been held, pamphlets and literature distributed, occasional conferences of physicians and health officers have been held, but these make up the list of its achievements in public education. To do more, some special agency must be provided.

It is proposed that this special agency shall be a School of Sanitary Science, established at Cornell University by the State of New York, under the direction of the State Department of Health jointly with the university authorities. Such a course has already been given at Cornell for two years and the instruction has been eagerly received. From 400 to 600 young men and women have already had instruction in sanitary science and public health and have learned the reasons for disease and, *except that the lecturers refuse to donate their time longer to the state* [italics ours.—Ed.], the course might be continued as at present with great benefit.

The present work is scattering through the state each year several hundred persons with a thorough knowledge of the reasons for preventable disease and the methods of prevention and the proposed school would not only continue this work, but would also provide special training for health officers and sanitary inspectors for which to-day there is no training given in this country. It would also carry on the campaign of education in this state similar to those devoted to agricultural extension work.

In this connection it should be noted that the comprehensive work done in agriculture is for the purpose of increasing the crop yields and improving the condition of the agricultural community. It is considered of such importance that the state yearly appropriates large sums for its maintenance, *yet for extending knowledge on subjects of public health no fund is provided* [italics ours.—Ed.]

This school should be established at Cornell University where the State Schools of Agriculture and Veterinary have already been established, and where adequate and reasonable methods of procedure in educational campaigns have already been worked out.

The State Department of Health regards the establishment of such a school at Cornell as but the entering wedge in this great field of educational effort. Its ambition and dream of achievement is that ultimately there shall be established in every college and university in the Empire State, similar schools, and to every such school established for the purpose of instruction in sanitary science the department pledges its earnest support and cooperation.

The bill already mentioned as having passed the legislature, and which, if approved by the Governor, would have been a notable step in beginning the educational work urged in the foregoing quotation, was in part as follows:

Sec. 1040. State school of sanitary science and public health.

1. In order to aid in acquiring practical knowledge and in diffusing useful information on subjects relating to sanitary science and public health among the people of the state of New York; and to promote scientific investigation and research respecting the principles and application of sanitary science, there is hereby established at Cornell University a state school of sanitary science and public health.

2. The object of said school of sanitary science and public health shall be:

To give instruction in such courses and in such manner as shall best serve the interests of the public in the conservation of health; to properly train and educate students and health officers in all matters pertaining to public health. To conduct investigations as to the nature, prevention and care of all infectious and contagious diseases, and other matters affecting the health of the people of the state of New York, and in general to advance the knowledge of sanitary matters. To conduct extension work in disseminating knowledge throughout the state by means of lecturers, publications, bulletins and reports, and in such other ways as may be deemed desirable in the furtherance of the aforesaid objects.

3. The Cornell University shall, with whatever moneys it may receive from the state for that purpose, administer the affairs of said school, with authority to appoint investigators, teachers and other officers and employees; to lay out lines of investigation, to prescribe the rate of tuition and the requirements for admission and the courses of study, and shall have such power and authority as may be necessary and proper for the due administration of such school; provided, that the course of instruction designed for the training of health officers shall be approved by the State Commissioner of Health. Said university shall receive no profit or compensation for administering the affairs of said school, but all moneys received from state appropriations therefor shall be credited by said university to a separate fund and shall be used exclusively for said state school of sanitary science and public health, and such kindred branches of knowledge as may be useful and proper.

The bill also provided that all charges and fees for the proposed school should be fixed by Cornell University and that the money so derived should be used for the current expenses of the school. The bill included an appropriation of $10,000 to start the proposed work.

Unfortunately for the success of this scheme, the bill from which we have quoted was considered by the Governor in connection with bills for the establishment of a number of other schools, including a state college of forestry at Syracuse University and a number of state schools of agriculture. All the bills were vetoed by Governor Hughes. His veto message was opened by the following paragraph:

We have not the money to undertake the establishment of these schools. The wise policy, it seems to me, is to provide for the suitable development and completion of the schools that we have before we establish new and separate foundations.

After the foregoing statement Governor Hughes remarked that the secondary agricultural schools already established at Alfred and St. Lawrence universities and at Morrisville had "led to the most importunate demands on the part of other communities" for like schools. He concluded his veto message with the following remarks regarding vocational training in general and the schools proposed by the bills before him, as follows:

There can be no question as to the desirability of providing throughout the state abundant opportunities for vocational training and especially for educational work along agricultural lines. But the best course to be taken to achieve the end is not so clear at this time that we would be justified in multiplying separate agricultural schools.

And certainly it would be necessary to have a large increase in our state revenues before we could enter upon the undertakings contemplated by the present bills. This is true also of the bills providing respectively for the establishment of a State School of Sanitary Science and Public Health at Cornell University, and of a State College of Forestry at Syracuse University, and of an Agricultural Experiment Station in Niagara County.

Charles E. Hughes.

LABOR COSTS OF PILE DRIVING.—Mr. De Witt C. Webb, Civil Engineer, U. S. N., reports the following approximate labor costs of driving piles at the League Island Navy Yard in 1903-05. Wages were about $3.50 per day for foremen, $3 for enginemen and $2.75 for wharf builders. General superintendence, repairs, etc., are not included in these figures. Piles were mostly from 30 to 35 ft. in length and were driven in rather soft ground with gravel bottom:

Work.	Number of piles.	Cost, each.	Remarks.
Crane track.....	730	$1.34	Government day labor.
Coal pier.....	504	1.40	Contract.
Quay wall.....	817	1.63	Contract.
Dry dock.....12,597		1.64	Contract.
Pier*	347	2.06	Contract.
Sea wall*.....	300	1.93	Contract.

*10 x 12-in. sheet piles.

Municipal Disinfecting Station at Westminster, England.

The more important, at least, of the British municipalities provide well-equipped stations for disinfecting clothing and various household articles which it is supposed may have been infected by persons suffering from various communicable diseases. Such a station at Westminster, England, accompanied with dwellings which house the disinfecting staff and offices and some of the other municipal offices as well, was

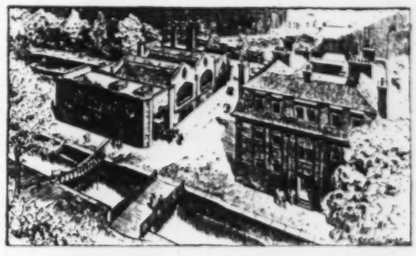


Fig. 1. View of Disinfecting Station and Staff Dwellings, Westminster, England.

described in the "London Local Government Officer and Contractor," for July 16, 1910. We reproduce therefrom the ground floor plan of the disinfecting station and a pen-and-ink sketch of the station and the staff dwellings. The following facts regarding the station are taken from the same source.

The exterior of the building which houses the disinfecting plant is faced with red pressed bricks. The interior is faced to a height of 4 ft. from the floor with white glazed brick. The interior walls above the brick, as well as the ceilings of the infected and the disinfected chambers, are lined with white tiles.

As may be seen from the floor plan, and also from the view, wagons with infected goods are driven to a shed at one end of the plant. The goods are then passed into an infected chamber, then through one or the other of two steam disinfectors out into the disinfected chamber, thence into a loading room. Finally, they are loaded into wagons in another shed.

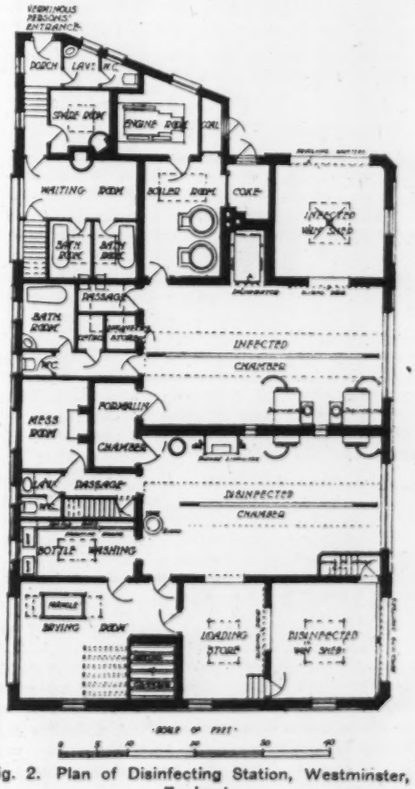


Fig. 2. Plan of Disinfecting Station, Westminster, England.

In a recess opening out of the infected chamber there is a small incinerating plant, built by Goddard, Massey & Co., well-known British manufacturers of refuse and other incinerators. Here mattresses, clothing, etc., too dirty to be cleaned, are burned. The incinerator has side walls and a top made up of steel plates, and has an interior lining of firebrick. There is a fire grate and ash pit and a baffle wall. The smoke and fumes from the burning articles are passed through the fire grate.

Still further it is to be noted that "provision is made for treating verminous persons."

The steam disinfecting apparatus is of the Alliot and Payton type, made by Manlove, Alliot & Co., which concern is also a well-known British manufacturer of refuse destructors. The steam disinfecting apparatus and its use, together with notes on some of the other parts of the plant, are thus described in our London contemporary:

The apparatus has an oval chamber, 7 ft. long, 6 ft. high, and 3 ft. 7 ins. wide internally, with double walls forming a jacket round, and steel-framed doors at each end. The object of the jacket is to heat the contents of the disinfecting cylinder before the steam is turned in, to prevent condensation and to assist in drying the contents after the steam has been withdrawn.

Articles to be disinfected are placed inside the apparatus, and the air is extracted. This is to facilitate the penetration of the steam, which is subsequently admitted under a pressure of 20 lbs., and at a temperature of 259° F. After the articles have been subjected to this for a sufficient period, the steam is allowed to escape and a second vacuum obtained, this being broken in its turn by hot pure air. Articles which are partially or wholly made with leather and furs, silks, letters, etc., cannot be subjected to steam without damage. These may be treated in the same machine either with dry heat alone or with formaldehyde gas. A special appliance is provided for the introduction of this gas, which may also be used in conjunction with steam. To each apparatus is attached a recording pressure gage, fitted with a chart on which a diagram of every operation is automatically registered. These charts are preserved, and afford a means of ascertaining the treatment to which the articles have been subjected.

Articles of clothing, bed linen, or which have been soiled with discharges, require to be soaked in cold water and washed before exposure to steam, which would fix any stain. A washing machine has therefore been added. In many cases treatment therein will be sufficient disinfection, and on removal the washed articles will be placed in a hydro-extractor and afterwards in a drying closet.

For furniture and large articles a special room has been provided in which formaldehyde, sulphurous acid gas, or other disinfectant may be applied.

The dwellings and offices shown in the view provide accommodations for the families of four disinfectors, two highway employees and also a lockmaster engaged on the canal shown in the view. Each dwelling is provided with a range, gas stove, hot and cold water, bathroom, etc. The office of the highways department of the city is housed in this building. The dwellings and office buildings are substantially built with external materials similar to those in the disinfecting station and a slate-covered roof. The floors throughout are of steel concrete, with sculleries, bathrooms and corridors finished with cement, and other rooms with a floor covering of "deal" [pine], bedded solidly in pitch and tar on the concrete. Slot gas meters are provided, and the dwellings have telephonic connection with the City Hall.

As a further indication of the care bestowed upon the design and equipment of buildings of this sort, it may be stated that the city has employed as architect Mr. John Murray, F. R. I. B. A. The buildings were constructed by contract, the award having been made to the lowest of 15 bidders at a price of £9,921 ($48,216). The cost of the equipment cannot be given in figures that would be of any value, in view of the fact that some of the equipment was moved from old stations.

The Design and Erection of the Missouri River Bridge for the Pacific Extension; C., M. & St. P. Ry.*

By J. H. PRIOR.†

In extending the Chicago, Milwaukee & St. Paul Ry. to the Pacific coast in 1907-1908, the first great river to be crossed was the Missouri, which was intersected where it sweeps through a flood plain one mile in width, 12 miles west of Glenham, So. Dak. On the bluff near the edge of this plain a town site was located and named Mobridge on account of its situation. The bridge (shown in Fig. 1) was designed and constructed by the Bridge and Building Department of the C., M. & St. P. Ry., under the direction of Mr. C. F. Loweth, M. Am. Soc. C. E., Engineer and Superintendent of Bridges and Buildings.

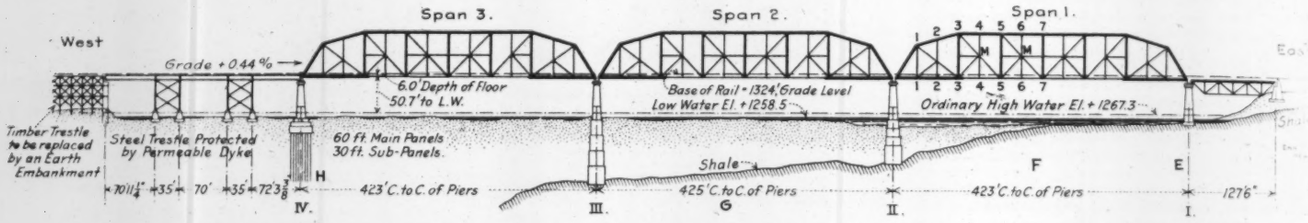


FIG. 1. ELEVATION OF THE MISSOURI RIVER BRIDGE AT MOBRIDGE, SO. DAK.; C., M. & ST. P. RY. (PACIFIC EXTENSION).

The track was put at an elevation of 65½ ft. above low water, to allow for a clear headroom of 50 ft. above ordinary high water, as required by the act of Congress. At the site, the low-water channel is 1,450 ft. wide, and the high-water channel is 100 ft. wider. The main channel is crossed by three 420-ft. through pin-connected truss spans, approached from the east by a 125-ft. deck span, and from the west by 283 ft. of steel trestle connecting to a long frame trestle. This last has been partially (and will be entirely) replaced by an earth embankment. The east abutment is a safe distance from the water, and the trestle at the west end is protected by a permeable dyke and woven willow mattress and stone riprap.

Design of the 420-ft. Spans.

The design of the main channel spans is shown in Figs. 2 and 3. It will be seen that the top chord was made horizontal over eight panels. This does not present the graceful appearance of a truss with a top chord which approximates the arc of the circle or parabola, but it has the advantage that it is not necessary to t... the entire chord stress of adjacent chords throug... bearing joint. Instead, the chord stress can be mitted through a joint in which the adjacent sec... the chord have their entire ends milled so as brought to a full bearing. The chord stress been taken care of in this manner, it is only n... to provide sufficient pin plates to transmit the in... of chord stress.

This is shown in detail at panel point (U5), ... At this point it is not necessary to transmit the chord stress in chord sections (U3-U5) through pin... to chord (U5-U7); instead, the pin plates are o... sufficient thickness to transmit the increment of stress at this point due to the horizontal com... of member (U5-M6). The stress in chord (U3-... transmitted to chord (U5-U6) through a bearing joi... to the left of panel point (U5), as shown. This arr...

ment is an advantage even in a short span, and is of much greater advantage in a longer span, as in this case the thickness of pin plates required to transmit the entire stress by pin bearing is so great that the grip of rivets through the pin plates is too long to permit of the rivets being driven tight in the average bridge shop. To further limit the grip of rivets and also to reduce the bending in the chord pins, the top chord and end posts were made with three webs, as shown.

The hangers (M6-L6) and (M4-L4) are somewhat heavier than the tension due to floorbeam reaction requires. They are subject to another stress, which is the bending due to the component of the bottom lateral system parallel to the center line of the truss tending to twist off the portion of the hanger below the pin, and acting with a lever arm equal to the distance from the center of the bottom chord pin to the plane of the bottom lateral plates at (L4) and (L6). The force is marked X, and lever arm Y, at (L4) in Fig. 2.

It was thought that it might be possible to design expansion rollers for this bridge with faces of some non-corrosive metal. But as no satisfactory way was found for connecting such metal to the face of the roller, and as the great weight of the rollers (60,000 lbs. for three spans), precluded the use of the non-corrosive metal

*Abstract of a paper read before the Western Society of Engineers, Chicago.

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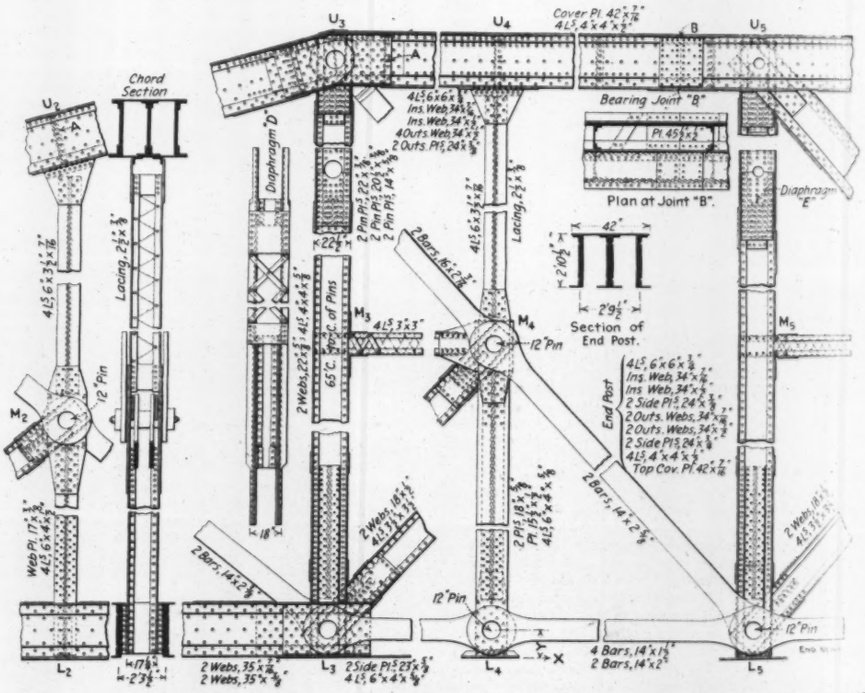


FIG. 2. PART DETAIL ELEVATION OF 420-FT. TRUSS, SHOWING SPECIAL FEATURES OF THE DESIGN.

throughout, the rollers were made of cast steel. The roller bed is a single steel casting instead of the common construction of track rails riveted together. The web of the ordinary rail is rather thin and this results in excessive stresses due to a compression caused by the weight of the span and also makes each rail rather unstable. These defects are avoided by the use of the steel casting shown.

Transverse diaphragms (A), shown at (U2) and (U3), Fig. 2, were placed in all compression members having three webs and at right angles to the axis of the members. These diaphragms keep the pin holes straight and true by maintaining the webs parallel and at exact distance apart, both while the member is being bored or fitted in the shop, and during the handling it receives before it is placed in the structure. The driving of the chord pins is thus materially facilitated. Diaphragms (D) at (U3) and (E) at (U5), are parallel to the axis of compression members and reduce the length of unsupported jaws to a minimum. Both top chord and end posts were built with cover plates. This was done as much to keep the members straight and true while being riveted, as to avoid some doubtful matters of lacing pro-

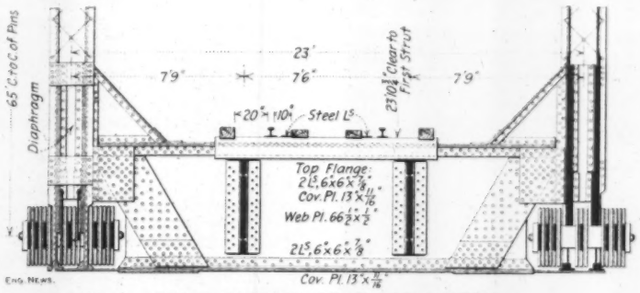


FIG. 3. CROSS SECTION OF FLOOR SYSTEM.

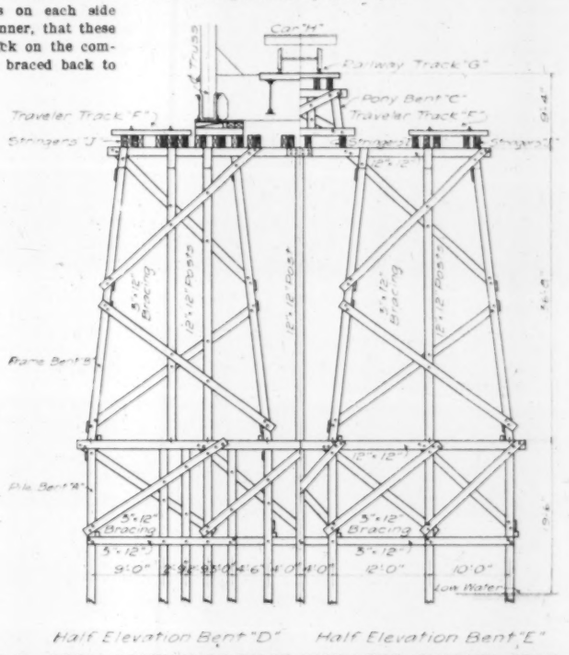


FIG. 5. CROSS SECTION OF FALSE WORK FOR CHANNEL SPAN.

portion concerning which there has been so much recent discussion.

On the outstanding leg of the stringer connection angle the distance between the gage lines A, Fig. 4, nearest the center line of stringer, is 10 ins. This permits (as shown to an exaggerated scale) the slight increase in the distance center to center of floor beams due to the elongation of the bottom chord under a passing train by a sort of hinge action in the stringer connection.

Erection.

The 125-ft. deck truss and the 420-ft. main channel spans were erected on falsework, but no falsework was used for the erection of the steel trestle at the west end.

A temporary pile bridge was built 90 ft. upstream from the permanent bridge, carrying a track 13½ ft. above low water. This was built (1) to carry material for the construction of the railway while the permanent bridge was under construction, and (2) to serve the construction work on the permanent bridge, although not most conveniently located for this purpose.

CHANNEL SPANS.—The main channel spans were erected on falsework by means of an ordinary bridge traveler. The falsework, Fig. 5, consisted of pile bents (A) extending 19½ ft. above low water and supporting frame bents (B) 36 ft. 8 ins. high; these support the stringers (J) carrying the traveler track (F), and also the stringers (I) carrying the pony bents (C), which support the railway main track (G). Bents (A), (B) and (C) are the several stories in the main bent (D), Fig. 6, which supports the truss at the panel points. Main bent (E), located midway between panel points, carries the traveler and railway track only. It is of somewhat lighter construction, but consists of three stories similar to bent (D).

The pile bents (A) in the ground from (E) to (F), Fig. 1, which was above water and dry, were driven by a track driver running on a temporary track which was laid on the bents already driven. The track driver drove one bent in advance, piles being cut off and capped, and stringers and ties placed on the cap to permit the pile driver to move forward.

The piles for the falsework from (F) to (G), and (G) to (H), Fig. 1, were carried out by push cars on the temporary pile bridge, and rolled off into the stream opposite the points where they were to be driven. The pile bents from (F) to (G) were driven by a pile driver mounted on a scow located as shown in Fig. 7. On one side of the scow a longitudinal timber (A) was attached at a distance from center of the leads which would give the correct spacing of the piles in the bents. The scow was placed with this timber bearing against the piles in the last bent driven and was allowed to float downstream each time a distance equal to the spacing of the piles. The scow was moved to and held in its position by a rope (C) running from the winch head on the engine to the temporary bridge, and also by a rope (D) running from the winch head on the opposite side through a sheave on the deck of the scow and then to one of the piles in the last bent driven. This served to hold the scow tight against the pile bent last driven and prevented its rotation in the current.

As shown in Fig. 5, the frame bent (B) consists of nine 12 x 12-in. posts, the four outer posts on each side being braced as a unit and in such a manner, that these four posts could be lowered from the track on the completed bents (A) with a derrick car and braced back to the finished portion of the falsework so as to support the stringers and track, thus completing a panel of falsework. The half-bents, consisting of four outer posts with their bracing, were assembled to a template on a platform on shore; from this they were picked up by the derrick car, carried out and put into place.

The piles for the falsework bents from (G) to (H), Fig. 1, were driven from a scow in the manner described. The frame bents (B) for this portion were assembled in a horizontal position on top of the pile bents and then raised into position by the derrick car, one panel at a time, in advance of the completed portion of the falsework, the derrick car operating from the railway track which rested on the steel floorbeams and stringers. In order to permit the derrick car to operate from the railway track, it was necessary to carry on the erection of the steel floor fast enough to place the floorbeams and stringers next to the end of the falsework structure as soon as the bents upon which they rested were erected. As soon as erected, the bracing was placed, giving stability to the bent.

The pony bents (C), Fig. 5, were not used in this portion of the falsework, the derrick car being carried by the steel floorbeams and stringers, each panel of which was placed as soon as the frame bents were raised into position. Fig. 6 shows at (D) how the steel floor was placed for the derrick car. The material for this portion of the falsework was that which had been previously

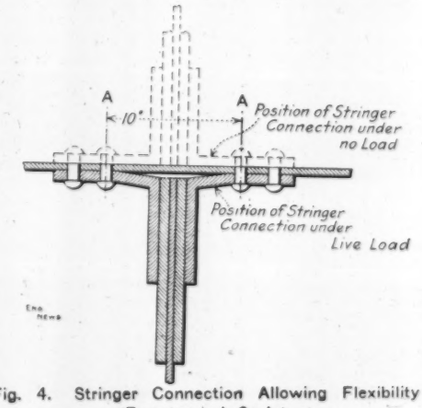


Fig. 4. Stringer Connection Allowing Flexibility (Exaggerated Scale).

used in span 1, Fig. 1, and was now available as this span had been erected and swung clear of the falsework.

The traveler which straddled the truss, Fig. 8, moved longitudinally on the traveler track (F), Fig. 5. The railway main track (G) was supported by the pony bents (C) until the erection had proceeded to a point where these pony bents, together with the stringers which they support, were removed, and the track placed with the steel stringers and floorbeams of the permanent bridge, as shown at (D) and (D1), Fig. 6.

The bents were placed 15 ft. centers. This permitted the use of the railway company's standard bridge material to a great extent without cutting, and made the second-hand timbers from the bridge only slightly less valuable than new material. It was possible to make the intermediate bents (E) of lighter construction than the bents (D) at the panel points, as they carry only the traveler and the railway track, the dead load of the trusses being carried by bents (D).

The traveler, Fig. 8, consists of three bents 85 ft. high, made long enough to erect one full truss panel of 60 ft., or two sub-panels of 30 ft. each, without moving; it extended 3 ft. beyond the panel point at each end, in order to afford a platform for the men while making the connections at three separate panel points.

The traveler was supported on each side by two rails (F). A runway of two rails instead of one gave a wider platform for the engines and increased the stability of the traveler; it afforded a place for the men to stand while driving the pins, and a place for them to work when the main track (G) was loaded with cars. The traveler consists of three bents which support the stringers (D), which in turn carry the tie beams (K), (L), etc., from which is suspended the tackle by which the loads are handled by means of a U-bolt shown at (E). The maximum load for which the traveler was designed was a top chord section which weighed 52,000 lbs.

The general arrangement of the traveler lines is shown on the cut. Power was furnished by four 30-HP. hoisting engines on the platform, two on each side. Each engine had two drums and three spools, as shown. Tie beams (L), (M) and (N) are similar to the tie beam (K), which is carried by the stringers (D) and has passed through it a U-bolt (E). This carries the blocks (a) and (b) which are rove with six parts of ⅝-in. steel cable, the lead line (a b), of which passes through a snatch block (d) at the top of the traveler, thence to the snatch block (e) at the bottom of the traveler and thence to the forward hoisting drum (q) of the engine. From the tie beams (L) and (M) are suspended four-part tackles (a3-b3) and (a2-b2) in a similar manner to the tackles from the tie beam (K). The lead lines (a3-b3) and (a2-b2) pass through the snatch blocks (d) and (f), respectively, at the top of the traveler, thence to the snatch blocks (e) and (h), respectively, at the bottom of the traveler, and thence to the rear hoisting drums (p) and (r) of the engines, respectively. The blocks (b1) and (a1) suspended from tie beam (N) have similar lines.

The tie beam (K) in addition to transmitting the load in the tackle to the stringer (D) acts also as a strut and prevents the lateral pull of the tackle when hanging at an angle with the vertical, from overturning the stringer (D) or pulling it laterally from its true position.

There are two runner lines from each engine, which were used to raise some of the lighter members; such as the line (m-n) at (T), which passes from the load which it is supporting to sheaves (m), (n) and (f), and thence to the winch head (X) on the engine. The runner lines run out to about the points shown in Fig. 8, but were shifted to suit conditions. The traveler was only used for the erection of trusses, the floor system and bottom laterals having been put in with a derrick car.

Fig. 8 shows the heavy top chord section being placed in position. The chord was run out on a flat car (H) to a point opposite its position in the truss. The tackles (a-b) to (a3-b3) from the tie beams (K), (L), (M), etc., were attached to the chord by a chain sling. The lead

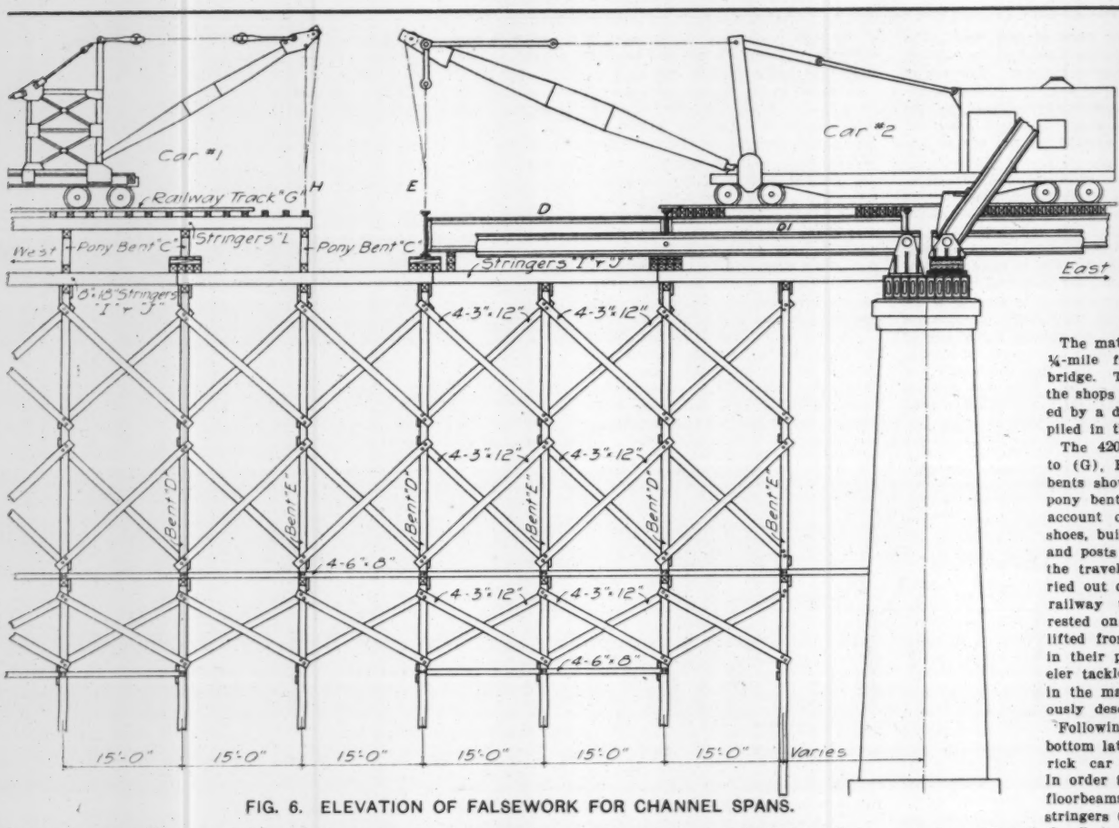


FIG. 6. ELEVATION OF FALSEWORK FOR CHANNEL SPANS.

lines on all tackles were hauled in until the chord was lifted clear of the car. By increasing the velocity of haul of the lead lines of the tackles in position (u) over those in position (y), the load is given a considerable lateral movement bringing it to the position (w) at a low velocity, but remaining under control of the tackle (y). This makes it impossible for the load to swing laterally with a velocity which would injure the traveler if the lateral drift of the load were not controlled. After reaching position (w) it was lowered into place, connections made and pins driven.

The lighter members were raised, as shown at (T), Fig. 8, by means of a tackle from one side of the traveler only, and when raised from the car were prevented from swinging laterally with any great amount of force by the snub-line (1), which was snubbed around some timber in the traveler and paid out under control, thus governing the lateral motion of the member.

The traveler was moved by means of a line having its ends fastened to the two piers and containing enough slack to permit its being wound (when required) three or four times around one of the spools of the hoisting engine, as at (Z).

Each bent of the traveler was framed in six sections on a platform on shore. These sections were carried out to a point on the falsework where the sills of the traveler had been previously placed and bolted together. The three bents were laid flat, placed partly one above the other, their feet being chained in position to the sills of the traveler, which in turn were fastened to the falsework. The first bent was raised by means of an auxiliary bent, 42 ft. high, by the seven-part block and tackle, one end of which was fastened to the top of the traveler bent and the other end of which rested on the top of the auxiliary bent; the lead line passed over the top of the auxiliary bent, down to a snatch block fastened to the falsework, thence to a spool on the engine of the derrick car. The bent was raised to position by hauling in the lead line, which caused the tackle to pull on the top of the traveler bent as it was revolved to a vertical position. The second and third bents were raised in a similar manner except that the traveler bents already erected were used instead of the auxiliary bent.

The material yard was located about ¼-mile from the east end of the bridge. The steel was shipped from the shops in gondola cars and unloaded by a derrick car, being sorted and piled in the yard as it was unloaded.

The 420-ft. spans from points (F) to (G), Fig. 1, were erected on the bents shown in Fig. 5, on which the pony bent (C) was used. First on account of their great weight the shoes, built-up bottom chord sections, and posts (L2 M2) were erected with the traveler, the material being carried out on flat cars running on the railway track (G), Fig. 5, which rested on the pony bents (C), then lifted from the flat cars and placed in their proper location by the traveler tackles (a-b) to (a3-b3), Fig. 8, in the manner similar to that previously described for the top chord.

Following this, the floor system and bottom laterals were put in by a derrick car in the following manner. In order to place bottom laterals and floorbeams, the pony bents (C) and stringers (L), Fig. 6, just in advance of the portion of the floor already placed and occupying approximately the position of the steel floorbeams and stringers about to be erected, were removed by derrick car No. 1, which had been backing away from the

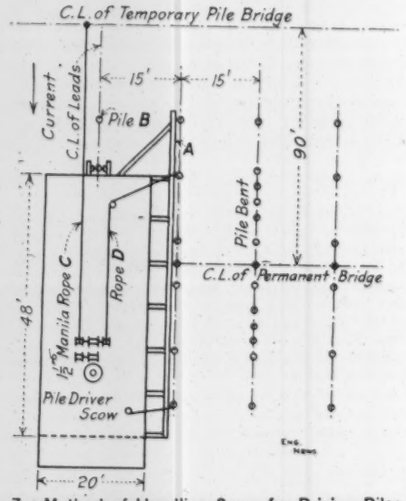


Fig. 7. Method of Handling Scow for Driving Piles of Falsework Bents.

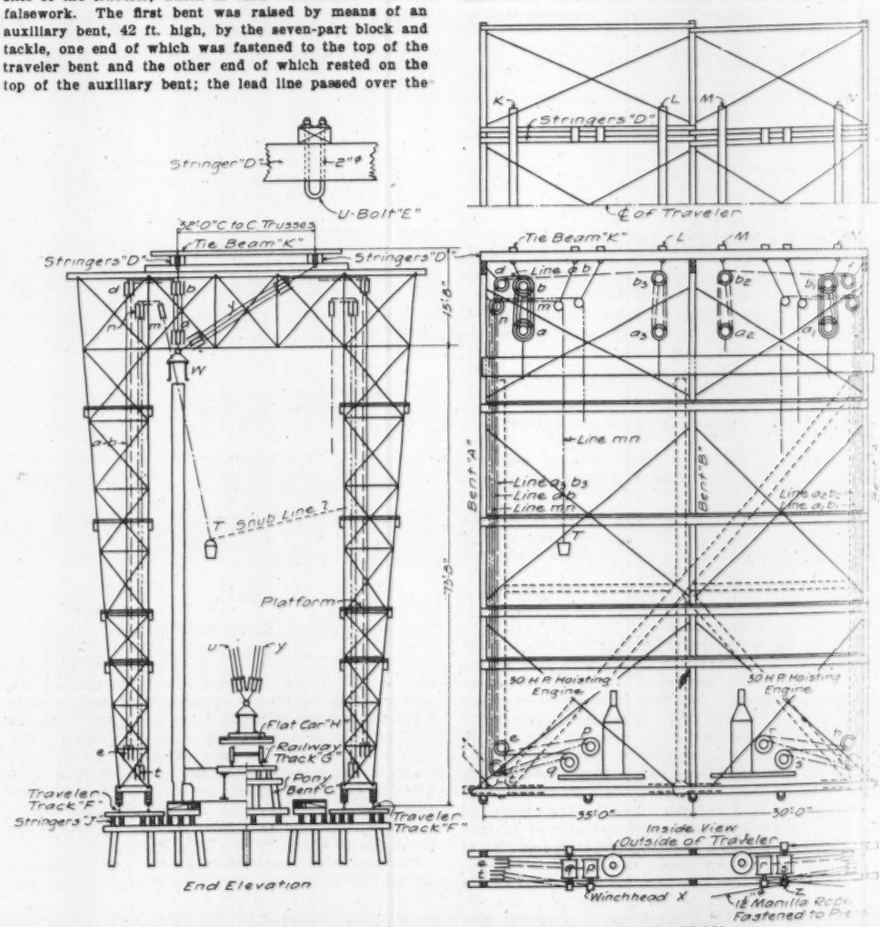


FIG. 8. TRAVELER FOR ERECTING 420-FT. TRUSS SPAN.

portion of the structure already erected. This derrick car removed the temporary floor in advance of the portion of the steel work about to be erected and placed the material from the temporary floor upon the falsework alongside, where it could be picked up and carried to the structure when the floor was connected.

After derrick car No. 1 had removed the panel of temporary floor immediately in front of it, it moved backward and picked up the next panel of floor to the west. Simultaneously with this, derrick car No. 2 had been operating as follows: A load of floor beams and stringers were pushed out on a flat car in front of the derrick car and unloaded on the falsework alongside of the track as near as possible to their final position longitudinally. The flat car in front of the derrick car was then pulled out and the derrick car returned and placed the floorbeams and stringers, which it had just unloaded, in their final position.

During the entire time that the floor system and bottom laterals were put in by a derrick car, the gap or the break in the track between points (H) and (E) was open. After the floor beams, stringers and bottom laterals were placed, the track was restored and all material erected from this stage in the erection onward was brought out under the traveler on cars and erected by the traveler.

The steel floor having been placed, the end connections of the floorbeams formed a convenient support to which all vertical posts could be fastened and be made secure without much guying. These posts, together with the

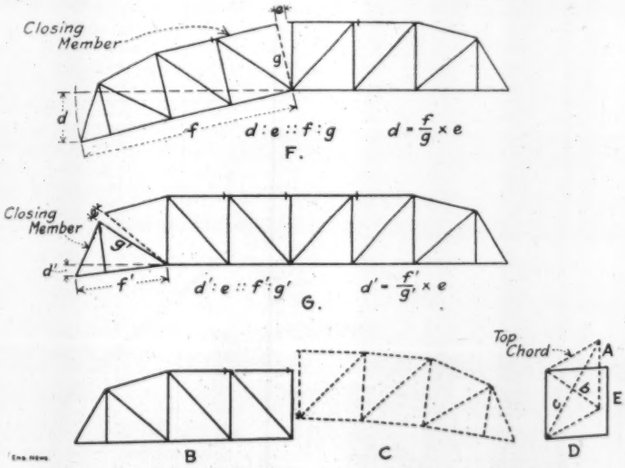


FIG. 9. CAMBER BLOCKING AND CLOSING CONNECTIONS.

other web members and the remainder of the bottom chord, were next erected. Enough material for one full panel of bottom chord and web members was run out at one time on flat cars on the railway track (G), Figs. 5 and 8, and erected by the traveler. Pins were then driven, except top chord pins.

Starting then with the center of the span and working to the east end, the top chord section, batter posts and top struts were put in, the pins being driven as the several panel points were reached. The traveler was then started back to the center of the span putting in the top laterals and completing the sway bracing of the span which it has just erected. The movement of the traveler continued past the center of the span to the west and erecting the remainder of the top chord, batter posts and bracing. The pins were driven with a steel ram 6 ins. diameter, 16 ft. long, and weighing 1,600 lbs.; this was suspended from the top of the traveler and operated by men working from whichever platform in Fig. 8 was below the pin to be driven. All bottom chord splices were riveted before the span was swung, and all other connections were riveted after the span was swung.

Two crews of nine men each were used on this traveler, one crew on each side. An average of about 14 days was required to erect each span, counting from the time that the first work was done in placing the shoes until the span was swung clear of the falsework.

The portion of the bridge from (G) to (H), Fig. 1, was erected in a similar manner, except that the falsework pony bents (C) were omitted, the steel floorbeams and steel stringers being placed on the falsework stringers (I), and the track laid on top of the steel stringers. The laying of the ties and rails on top of the steel stringers completes the track in the panel. Then the derrick car can run out on this portion of the track which rests on the erected portion of the steel floor, and can erect in a similar manner the floorbeam and stringers another panel ahead of the completed portion of the structure, as shown in the right-hand portion of Fig. 6. On account of the danger of the approaching high water, the erection of the steel followed closely after the erection of the falsework from (G) to (H).

One derrick was employed either in upending the frame bents (B), which were assembled on top of the pile bents (A), or else was employed in placing the stringers. As soon as the panel of falsework had been completed, this car moved back to pick up and place the steel floorbeams and stringers necessary to complete the panel. In this way the erection of the falsework and the erection of the steel upon it were carried on practically simultaneously.

The end posts or the end top chord section at one end are the last members of the truss to be erected, as previously described. This is due to some features of camber blocking shown in Fig. 9. The full-line diagram (B) shows an outline of the truss when subjected to the dead load of its own weight. The dotted lines at (C) show (to an exaggerated scale) its outline when resting on the camber blocking, each panel being distorted as is shown in dotted lines at (D) in such a manner as to make the diagonal distance (b) less than the diagonal distance (c) and less than the true fabricated length of the member which will be located in the diagonal (b). It is a simple matter to give each panel the shape shown at (A) by means of camber blocking, as the rectangle formed by the top and bottom chords and the posts, approximates a four-sided figure each side of which consists of a stiff member but which is hinged at the corners.

As the length of the diagonal distance (b) is less than the member occupying this position, by decreasing the amount of camber blocking, the panel at (A) can be brought toward a position shown by light lines (E) in which the distance center to center of end pins on diagonal (b) is exactly equal to the distance center to center of end pins of the member which occupies this position in the structure. Allowance is made for the conditions of sag, temperature, etc., under which the member is being erected.

This use of the camber blocking permits making the necessary adjustments so that all members of the truss can be erected except the closing side. If the center section of top chord, in the diagram (F), is chosen for the closing member, any error between the fabricated length of the top chord and the space left for it in the truss in amount equal to (e) would make it necessary to alter the elevation of truss by the amount d equal to $f \times e \div g$. But if the end post is chosen as a closing member, the total amount of vertical movement required for a similar error of like amount is shown in diagram (G) to be $f^1 \times e \div g^1$, or about 3/5 of the foregoing. An advantage is also obtained through the pin connection at either end of the end posts which permits of the use of the large force available from a pilot nut driven by a ram to force the last member into position.

STEEL TRESTLE.—The steel trestle approach at the west end for which no falsework was built, was erected as follows: As the bridge was erected from the east, it was necessary to carry the material for the steel trestle through the 420-ft. spans. As the portals and the transverse bracing for these spans limited the clear headroom, it was impossible to bring out columns for the steel trestle suspended from the boom of the derrick car without fouling the transverse bracing of the trusses. Two columns, therefore, were loaded on a flat car which was pushed out ahead of the derrick car to a point near the west end of span III., Fig. 1, adjoining the trestle approach. The columns were then lifted from the car by the derrick car boom, one column being placed each side of the track resting on the floorbeams, as there was sufficient room to store these in this position for a few hours.

Following this, two panels of transverse bracing for one bent and laterals for one girder span were loaded on a flat car in the same manner, pushed out and unloaded on a few temporary timbers laid from the top flange of the stringers to the bottom chord of the truss. The lateral bracing for one girder span which had been placed on the same car with the transverse bracing for the bents, was unloaded by being merely thrown from the car onto the track between the rails. The members being light and containing no large projecting gusset plates, their position between the rails did not affect the clearance for cars moving over them.

The flat car was then removed. The derrick car returned and picked up one column, to the top of which had been fastened longitudinal and transverse guy lines. The derrick car moved forward with the column at the end of the boom on the portion of the structure already completed, the length of the boom, 80 ft., permitting it to place the column a full span in advance of the completed portion of the structure. The remaining column of the same bent was placed in a similar manner and the two upper panels of transverse bracing were placed by being carried out on the boom of the derrick car and lowered into place by a runner line. When the connections of these two upper panels had been bolted and driven the column was stable transversely, and longitudinal guy lines made it stable longitudinally.

The girder was then brought forward on the boom of the derrick car and lowered into position, being held by the tackle until the ends were bolted and until the nearest end of the girder had been guyed. The second girder of the span was placed in a similar manner. The girder cross frames were then placed with a runner line from the boom of the derrick car, and the top and bottom laterals were placed by hand and bolted to the lateral plates which had in turn been bolted to the girder before it was lifted from the car.

Next, the derrick car returned to shore and brought forward, suspended from the boom, ties for the girder span. These ties were lowered to the deck and simultaneously the bridge carpenters commenced spacing the ties and laying the track rails, while the iron men were placing the longitudinal tower bracing with the boom. This operation completes the erection of the bridge.

Rat Suppression for Plague Prevention in San Francisco, Cal.*

By G. M. CONVERSE.†

The last case of human plague in San Francisco occurred two years and four months ago; the last case of rat plague was found 18 months ago; all of the anti-plague work done in San Francisco since that time has been, therefore, mostly in the nature of a prophylactic measure against reinfection.

The work being carried on at the present time has for its purpose (1) the destruction of rats and (2) the permanent rat-proofing of such sections or premises as are shown to be centers of rat population.

Destruction of Rats.

At the present time 30 laborers are employed exclusively as trappers; they are divided into four squads, each squad under the charge of a foreman who is responsible for their work. Each squad is housed in a different part of the city.

The city is divided into 60 sections, each trapper being allotted two sections. He attends the traps of these sections on alternate days.

The total number of traps actually placed and in constant use is close to 8,000, the number allotted each trapper varying with the topography of his sections.

Of numerous kinds of traps only two are practicable for extensive trapping operations. They are the cage trap and the snap trap. Of these, the snap is by far the easier to handle and can be placed almost anywhere, whereas the cage trap, being much larger and liable to interference from persons living on the premises, can be used only where such interference is not apt to occur.

The result of trapping for one month (May, 1910) is shown in the following table:

Nature of premises trapped.	No. of such premises trapped.	Daily number of traps set.		Total rats trapped.
		Cage.	Snap.	
Sewers	559	552	89	1,588
Stables	216	139	586	811
Restaurants	226	117	751	995
Bakeries	21	11	56	40
Stores	670	308	1,894	2,140
Factories	85	85	314	319
Dwellings	649	205	1,247	987
Warehouses	50	92	258	240
Vacant lots	80	35	126	231
Water front	1	91	196	250
Steamers	41	59	139	288
Butchertown	39	59	259	662
Total rats trapped in May, 1910	...	...	...	8,561

The amount of bait used during this period of one month was: Bacon, 312 lbs.; cheese, 104 lbs.; bread, 620 loaves. The bacon and cheese are used for the snap traps; the bread is cut into pieces in size about 2 ins. cube and placed in the cage traps, it having been found by experience that for this trap the bread serves the purpose as well as the more expensive cheese and bacon.

Destruction of rats by poison is now limited to the distribution of poison in the sewers. It is not deemed safe at the present time to distribute poisoned bread about premises. During the month of May 27,452 pieces of poisoned bread were distributed on boards placed in the sewers.

Permanent Rat Proofing.

A record of the location of each rat trapped is kept in a record book. These records are of use as evidence in proceedings of condemnation of premises.

As it is difficult by any system of book record to obtain an accurate knowledge of the distribution of the

*Report to the U. S. Public Health and Marine-Hospital Service; reprinted from "Public Health Reports" of the Service named, dated June 8, 1910.

†Acting Assistant Surgeon, U. S. Public Health and Marine-Hospital Service.

rat population of the city, the rat catch is shown graphically on a large map made especially for that purpose. The result of this graphic demonstration has been the location of three principal centers of rat infestation, as follows:

(1) The wholesale fruit and produce section occupying from 15 to 20 square blocks in close proximity to the water front.

(2) A triangular section of about 25 square blocks in the heart of the unburnt portion of the city, occupied mostly by Japanese population.

(3) That section known as Butchertown.

Elsewhere in the city the rats are found scattered and almost inevitably in or close to premises containing much food, such as restaurants, bakeries, etc. During the actual epidemic work much of the wooden flooring covering basements and yards about the city was removed, but there still remains a considerable amount, and it is mostly about such premises that the rats harbor.

WHOLESALE FRUIT AND PRODUCE SECTION.—By request or by condemnation proceedings practically all of the buildings in the first or wholesale fruit and produce section have been under consideration. Many of the old shacks have been taken down and replaced by brick or concrete rat-proof buildings; the owners have rat-proofed the basements of others; there remain a small number of premises on which nothing has been done owing to the fact of expiring leases and for other reasons. However, sufficient work has been done in this particular section to diminish the density of the rat population very markedly. Thus, in a period of six months from June 1 to Nov. 1, 1909, over 3,000 rats were trapped in this section; the succeeding six months furnished only about 750.

JAPANESE SECTION.—The number of rats trapped in this section during the past twelve months was 5,205. The principal causes of rat infestation in this section are overcrowding, carelessness in the disposal of garbage and refuse, and the construction of flimsy wooden additions and wooden flooring in all available corners of the property.

The blocks in this section are being taken up one by one and, by request or condemnation proceedings, all wooden flooring is being removed and replaced by concrete. Thus in the period of six months just elapsed there have been removed (in this section alone) by request 43,261 sq. ft. of wooden flooring and 40,641 sq. ft. of concrete have been laid; by condemnation proceedings 36,941 sq. ft. of flooring have been removed and 32,710 sq. ft. of concrete laid. Thus we have a total in this section of 80,202 sq. ft. of rat-harboring wooden floors removed and 73,351 sq. ft. of concrete laid.

The difference between the area of flooring removed and the area of concrete laid is accounted for by the fact that the law provides that open yards need not be concreted and that the earth may be left bare.

BUTCHERTOWN.—This section is situated on the shore of the bay and is partially isolated from the main portion of the city by a marsh about one mile in width. It consists of a number of old wooden buildings elevated on piles above the soft mud bottom of the shore.

During the time of the epidemic the rat population under the slaughter houses was enormous; in the wrecking of one of these nearly 2,000 rats were killed. Temporary rat-proofing was carried out, but as the offal is thrown beneath the surface of the slaughter houses on the tide land below and the rats find all the food they require they are still numerous, about 3,000 having been trapped in the few blocks covered by the slaughter houses during the last six months. One of the large firms has just completed a new brick and concrete slaughter house, and it is hoped that the record of rats caught outside of this place and the proving of the fact that this method of construction will do away with them will make it possible to attack the problem as a whole.

While the work of permanently rat-proofing the city is thus focused on certain locations, yet, wherever any building or group of premises shows a record of rats being constantly caught therein the premises are investigated and the necessary concrete is requested or obtained through condemnation proceedings. It is not to be hoped to rid a city constructed of wood of its rat population, but it may be possible to keep it mostly in the sewers or so scattered or so few in numbers that this condition alone would make a rapid transmission of plague infection improbable. This result would make it possible to limit any fresh plague infection to a circumscribed focus.

About the beginning of May the city authorities appointed inspectors to serve under the orders of the U. S. Public Health and Marine-Hospital Service, but paid out of city funds. With these inspectors it has been possible to begin a systematic reinspection of all premises in the city; the result of this reinspection at the present time seems to show that the people have learned a lesson of cleanliness. It is fully a year and a half since systematic inspection of premises has been possible, and in spite of that fact the reports from all sections as to cleanliness of premises and the proper disposal of refuse are very nearly as good to-day as they were then.

Thermit Practice in America in Welding, Casting and Metallurgy.

By ERNEST STUTZ.*

Important among the recent developments in the industrial arts are the modern methods of joining metals of similar and dissimilar character. It is a case of the demand creating the supply. The traditional methods of joining iron to iron were by forging and burning on, but both those methods could deal only with metals of identical character.

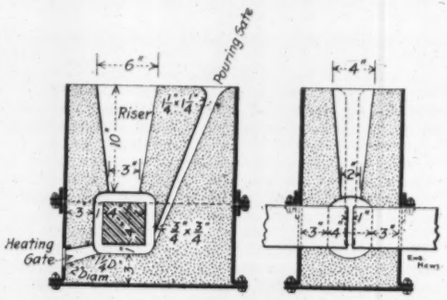


Fig. 1. Typical Thermit Mold, Showing Space Left for Collar, Gates and Riser.

Modern industry required not only means by which metals of dissimilar character could be joined, but also methods that should be more adaptable to varying requirements. In a comparatively short space of time, a number of processes have been presented, such as electric welding, various brazing methods, the Thermit process of welding, and welding by means of the blow pipe burning acetylene or hydrogen mixed with oxygen. All these methods are gradually sifting down to a state where each will take care of a special field of usefulness and while, in a broad sense, they all aim at the same results and so might be considered competitive, the limitations imposed in each case by the source of power and heat restrict them to territories which overlap only in a few instances.

Distinguishing Features of the Thermit Process.

The method of obtaining heat and power in the Thermit welding process is based on the discovery that finely divided metallic oxides mixed in volumetric proportions with finely divided aluminum will, when ignited in one spot, produce a temperature of about 5,400° F. within half a minute without any supply of heat or power from the outside. The affinity of aluminum for oxygen is such that it will draw the oxygen out of the metallic oxide and combine with it to form aluminum oxide, setting the metal free; and since the metal is the heavier of the two, it will sink to the bottom of the containing vessel. For welding purposes the metallic oxide used is iron oxide, and the reaction takes place according to the formula $Fe_2O_3 + 2\ Al = 2Fe + Al_2O_3$. This iron Thermit, commonly known simply as Thermit, will give half its weight as liquid steel.

The fact that no outside heat or power is required, to produce superheated liquid steel, frees the application of the process from the necessity of settling on one or more fixed points at which to install its apparatus. On the contrary, the superheated liquid steel can be produced and applied for welding at any point desired in any quantity. All that is necessary is to have containers or crucibles of sufficiently refractory quality and of various sizes to allow of the reaction of Thermit in quantities of from two or three to several hundred or even thousand pounds.

A distinctive feature of the Thermit process is, therefore, the transportability of the outfit to any given point, allowing the welding operation to take place without disturbing, in most cases, the fixed position of parts to be joined. Whatever the nature of the weld, whether on rails, on wrought-iron or steel pipes, on steel castings or steel forgings and, in some cases, machinery castings, the welding operation takes place while the pieces to be joined are in their working position. This gives the process a distinctive field of usefulness.

Method of Welding.

The operation, with the exception of a special variation in the case of pipe welding, proceeds on the same lines in all Thermit welding and may be shortly described as making a steel casting of superheated liquid steel around the parts to be joined. Owing to the high temperature of the liquid steel it will fuse with these parts and form upon cooling one homogeneous mass.

In performing the welding operation it is usual to proceed in the following manner: The parts to be joined are held in position, separated by an interval of from ¾-in. to 1½ ins. or 2 ins., according to their size. Around this space between the parts is then formed a mold, allowing for a reinforcement or "collar" which overlaps

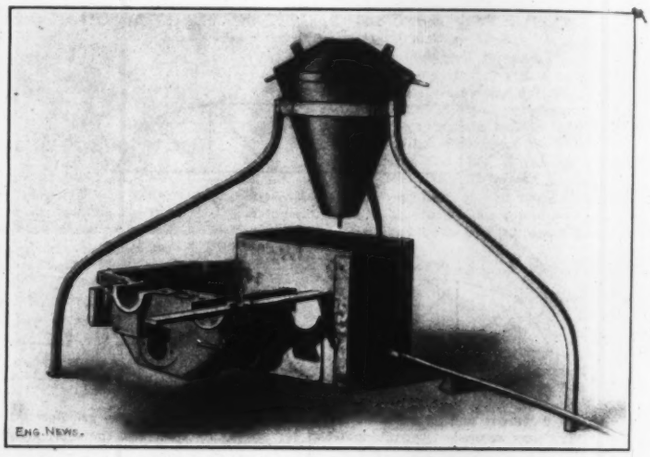


FIG. 2. COMPLETE APPLIANCES FOR MAKING A THERMIT WELD.
(Crucible is placed in position over pouring gate of mold, while the fracture is being preheated with a gasoline torch.)

Fig. 3. A Completed Thermit Weld, Showing Metal Left in Gate and Riser.
(This metal is afterwards removed, but the collar is left in place.)

*Vice-President and Treasurer. Goldschmidt Thermit Co., 90 West St., New York City.

the adjacent ends of the pieces. The mold contains a gate so constructed that it will direct the liquid metal downward to the lowest level in the mold so that the superheated steel will rise from there up through the collar and, having filled the collar space, will flow up into a suitable riser. The riser must be large enough to hold a quantity of metal equal to that forming the collar, or casting, itself. The construction of the mold is shown in Fig. 1, and in Fig. 2 the complete apparatus. Fig. 3 shows a completed weld after the mold has been removed.

The quantity of Thermit necessary to produce the steel to exactly fill this mold has to be accurately calculated by allowing 4½ ozs. of steel per cubic inch of space in the Thermit collar, or casting, including the interval between the parts to be united. To produce 4½ ozs. of steel takes 9 ozs. of Thermit. As stated above, however, it is necessary to have as much metal in riser and gate as in the collar and casting itself. For that reason, 18 ozs. of Thermit, instead of only 9 is required per cubic inch of collar or casting to be filled. This formula is somewhat modified in larger operations, by the addition of steel punchings and a calculation will be unnecessary when beeswax is used as a matrix for the collar.

Not wishing to give in this place accurate technical instructions the author will confine himself to stating that the proper practice in making Thermit welds in this way on an industrial scale is to form the collar of beeswax, form the mold around this matrix and provide in the mold, besides a gate and a riser, a preheating hole. Into this preheating hole is directed a gasoline blowtorch, which melts out the wax, dries the mold and brings the ends of the castings to a bright red heat. This description is inserted here only in order to bring out the fact that the weight of the melted wax in pounds, if multiplied by 32, will give the weight of Thermit necessary for the operation.

Practical Applications in Welding.

The development of the Thermit process, which originated in Germany about the beginning of this century, has been influenced by the prevailing conditions in the various countries in which it has been applied.

While the United States has offered a wide field for repairs, particularly on locomotive frames, and has, in this kind of work, far outstripped anything done in other parts of the world, the welding of rails appears to have met with wider recognition abroad than in the United States. It is evident that the process must adapt itself to the engineering practice prevailing in each one of the countries where it is to be applied. In Europe there is a very small field for locomotive repairs for the reason that the foreign engines are constructed on steel-plate frames. On the other hand, the rails used for street railway traffic in the United States are heavier and of a different composition from those in Europe. The manner of track laying differs no less from foreign practice than the means and organization of transportation; not to mention the fact that there are few parts of the world so densely populated, in a climate

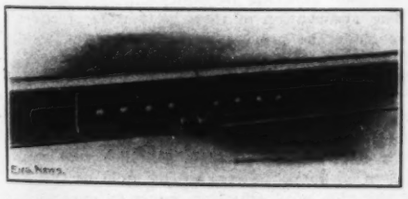


Fig. 4. Street Railway Track-Joint With Riveted Splicebar and Thermit-Steel Shoe Around the Base of Rail.

(A joint devised by Mr. Charles H. Clark, M. Am. Soc. C. E., of Cleveland, Ohio.)

showing such large and sudden difference in temperature, as the Eastern and Middle Western States of America. The methods pursued abroad in track laying have also permitted the use of different auxiliary appliances, such as the use of rail clamps, by which, without very materially adding to the cost and time of operation, a butt-weld of the head of the rail can be obtained.

RAIL WELDING.—The application to the welding of rails as hitherto practiced in the United States relied entirely on supporting the joints by a Thermit shoe or collar, extending around the base and web up to the under side of the head of the rail. No attempt was made to join the heads of the rails beyond the ordinary care taken that, before welding, they should present a smooth and uninterrupted surface, in case of need by the introduction of shims. Such work was done sometimes with, sometimes without the instructions of the Goldschmidt Thermit Co.'s engineers and has found particularly consistent application in the city of Los Angeles where over 20,000 joints have been made by this method.

The great advantage of the Thermit process of rail welding consists, of course, in the fact that the fusion between the Thermit steel and the rail material offers an ideal conductor for the return current through the rail. Furthermore, it was of immense advantage to street railway companies to be able, with the light and easily transportable equipment, to weld at one time as few and as many joints as they desired, practically without interfering with the traffic. Even where this method of welding has not been adopted in its entirety, the advantage of obtaining a rail-bond which at the same time can be utilized to give additional support to the rail ends at the joints, has led to its application in combination with regular rail-joints.

Mr. Charles H. Clark, Engineer of Maintenance of Way of the Cleveland Electric Ry., has de-

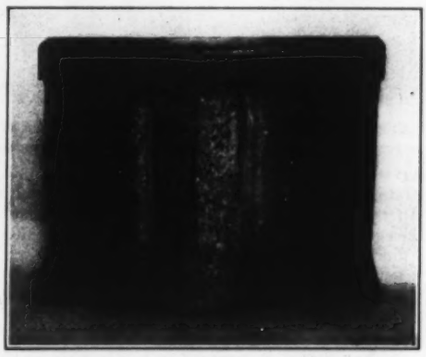


Fig. 5. Thermit Weld of Entire Rail Section.

veloped a joint, using hot-riveted fish plates but combining therewith a Thermit shoe around the base of the rail, and this combination has been received with a great deal of approval by prominent street railway engineers (see Fig. 4). A similar idea has been previously applied abroad in welding the conductor rail of a suburban line between Berlin and Grosslichterfelde by running a lump of Thermit steel around one-half of the base of the rail.

The most perfect rail joint will be the one that welds the entire section of the rail. The difficulty in achieving this result has always been that in order to do so it was necessary to interfere with the running surface of the rail. The latest method developed by the Thermit process minimizes this inconvenience to such an extent that it offers no practical objection. Welds of this kind, the so-called "solid section joint," have been made on Central Bridge in New York City under the most difficult conditions, on a bridge rail in asphalt on curves and on draw spans where the ends are loose, and have given perfect satisfaction under severe traffic conditions in several years' use. Such a weld is shown in Fig. 5. To obtain this joint it was necessary to separate the ends of the rails and to make the mold on the track. A riser has to be provided on the running surface of the rail but this is easily removed. The necessary appliances for performing such work are rather numerous but were all carried on a single two-horse truck.

Fig. 6. Two Thermit Welds on Front Splice of Locomotive Frame.

WELDING STEEL CASTINGS AND FORGINGS.—It is in the method of making repairs on steel castings in place that the American practice has solved its own problems with conspicuous success. Right from the beginning of its industrial introduction in the United States, it was confronted with the question of how to weld broken locomotive frames without dismantling the engines. That problem may now be declared to be finally and completely solved. The difficulties in accomplishing the results were numerous: first, and foremost, was an insufficient understanding of the frames by those who had the knowledge of the Thermit process and an insufficient understanding of the process by those who had had the experience with the frames. It is most satisfactory, however, to observe that there are now a large number of foreman blacksmiths on the various railroads of the United States who are fully conversant with the proper application of the Thermit process, although, as a casting process, it must be strange and unfamiliar in the light of their ordinary training and experience.

A great step in the successful use of this method of welding was made when the means of drying the mold and bringing the casting to a high temperature were simplified so as to be performed in one operation. This was achieved as soon as the usefulness of a wax matrix in connection with making a mold had been learned. As before described, the wax is applied hot in the shape in which the reinforcement collar is to remain on the casting. By a suitable arrangement of wooden cores for the preheating gate, pouring gate and riser, the mold can be made on this wax matrix. The wooden cores, or sprues, are withdrawn and the flame of a strong torch is directed into the preheating hole. This melts the wax, dries out the mold and brings the ends of the casting to a bright red heat within the space of a few hours, even for very large sections. The preheating of the ends to be joined produces a better casting as it allows accumulated gases to escape before amalgamation with the Thermit steel takes place.

A locomotive frame repair is shown in Fig. 6. Of course, the use of this process in railway shops is by no means confined to the welding of locomotive frames in place. It has been found perfectly practicable to weld mud rings, and the welding of connecting rods and the spokes of locomotive driving wheels by the Thermit process is a regular practice with numerous large railway companies. (See Fig. 7.) It has also been found practicable to weld grease cups onto connecting rods, and broken heads onto cylinders.

Still greater can be the saving to ship owners, as the size of the operation by no means hampers the application of the process. The repair on

which this method of welding has found its widest use in shipyards is that of broken sternposts, as illustrated in Fig. 8. Before its development, a broken sternpost could only be temporarily patched or had to be removed entirely from the vessel, an operation which took weeks of time, in addition to the high cost of a new casting or forging.

In spite of the opposition of conservative individuals and organizations and of rival industries, quite a number of these repairs have been satisfactorily performed, including the welding of fractured sternframes, sternposts, rudder posts, rudder frames and propeller shafts. A list of these repairs performed in North America during the past five years includes sternframes up to 6¾ × 11 ins., sternposts up to 13 × 16 ins. and shafts up to 9 ins. diameter. In some instances the whole operation, between dockings, has been performed in 48 hours.

Other repairs are, of course, too numerous to classify or describe. They have ranged from the largest fly-wheels broken through the spoke and rim to anchors, and dredge buckets, and from crank shafts (from 9 ins. to 20 ins. in diameter) and wobblers on rolls, to small repairs on truck frames, motor castings and axles.

FIG. 7. THERMIT WELD ON LOCOMOTIVE DRIVING WHEEL.
(Four spokes welded in two operations.)

FIG. 8. THERMIT WELD ON STERNPOST OF A STEAMSHIP.
(Photo taken before removal of metal left in pouring gate and riser.)

REPAIRS ON GRAY IRON CASTINGS.—It stands to reason that a process that uses aluminum in order to produce steel and which necessitates considerable expense in transportation and erection of appliances will find its most economical application, generally, in cases where the value of the casting is not the only factor to be considered but where the element of time has also a money value in restoring an important machine or appliance to working order with a minimum of delay. Such conditions are not always met with, and in particular the repair that most frequently offers, viz., on gray iron, is a poor business proposition for the reason that in a large number of instances the cost of the repair will approximate the cost of a new iron casting. Of course, this applies to gray iron in particular on account of its cheapness and the number of foundries able to turn out castings in short order.

Apart from the economical reasons militating against a frequent use of the Thermit process for repairs of gray iron, there is a not less important handicap due to an intrinsic characteristic of the gray iron itself. The melting point of this material being very much lower than that of steel, it has a much lower shrinkage coefficient. After superheated liquid steel is poured onto gray iron, strains will be developed in the casting, while cooling, the force of which it is hardly possible to estimate and which can be guarded against to a certain extent only by very careful preheating and gradual annealing after the pour. As a matter of fact, thin sections of gray iron and parts that are cored or at all exposed to unequal contraction and expansion had better not be welded with Thermit. There is no difficulty in making a weld, but a shrinkage crack is liable to occur and destroy all the benefit of the operation. Such shrinkage cracks will occur hours and even days after the welding operation has been performed. Where it is decided to use the process on gray iron, an admixture of from 2% ferro-silicon and 1% manganese.

While the Thermit process is, therefore, not always recommendable for repairs of gray iron, it can lend valuable assistance in the process of "burning on," that is, repairing a broken gray iron casting by running over it a large quantity of molten gray iron which gradually brings the surfaces to be joined to a fusing temperature. It is manifest that a large quantity of iron would have to be run past a metal surface before the latter would be softened to such an extent that the flow can be stopped and the remaining metal be left to cool and amalgamate with the original material. The largest part of the iron run past the surface is used simply in order to increase the temperature of the cold casting. By using the Thermit steel in place of gray iron, this process can be materially simplified and cheapened. All that is necessary is to so construct a mold that the liquid steel can be run on to the welding surface, bringing it much more quickly to the necessary welding temperature. Gray iron is then poured through another gate and will displace the Thermit steel while benefiting by the heat so produced. By this method,

Fig. 9. Welding a 1¼-In. Pipe in a Trench by the Thermit Process.
(Showing clamps for forcing the pipe ends together.)

various heavy gray iron castings have been saved, but in particular should be noted repair of broken rolls in places where no is available. The wobbler is usually the that breaks off and if gray iron is available would be no difficulty in welding a gray iron wobbler on to a steel roll.

PIPE WELDING.—The heat producer in all the operations on solid castings is the superheated liquid steel resulting from the chemical reaction. However, as shown in the chemical formula, besides the superheated iron there results an aluminum oxide or slag. This slag is equal in weight to the Thermit steel produced, but its volume is three times greater. It is a pure aluminum oxide (Al_2O_3) and being the lighter of the two will float over the iron. In making repairs on solid castings, the operation takes place in a crucible so arranged that it can be tapped from the bottom. The steel will, therefore, flow into the mold and the slag following it will be diverted away from the weld, being in all these cases a waste product. This slag, however, has quite valuable properties, inasmuch as it is very highly refractory. It will solidify more quickly than steel, and though it remains at a high temperature for a long time, it will, after it has once solidified, prevent any liquid steel from breaking through it.

The observation of these properties of the slag has made the process adaptable for the welding of wrought-iron and steel pipe. The ends of the pipe, tightly fitted together, are surrounded by a mold and held between clamps, as shown in Fig. 9. The Thermit is then poured into the mold in such a manner that the slag runs in first. This slag, as above stated, solidifies very rapidly and in so doing adheres to the mold or the walls of the pipe with which it comes in contact. By the time all the slag is poured into the mold and the steel begins to follow, the latter will not come in contact with either the mold or the pipe. The heat of the slag and the steel combined, however, are quite sufficient to bring the metal of the pipe in the mold to welding heat. In that condition, the clamps force the pipe ends together and form an absolutely tight weld with no change of the pipe, except a slight upset on the outside.

The extraordinary rapidity and simplicity of

making these welds has never failed to arouse surprise and approval. The outfit is so small that one man could carry in his hands all the tools and appliances necessary for four or five welds of the smaller sized pipes, and with these small appliances, welds can be made in place without further difficulty.

For large diameters, say 7 ins. to 8 ins. and over the process would hardly be economical on account of the difficulty and expense of using clamps of the necessary size and strength and also on account of the quantity of Thermit necessary for such welds. But 4-in. double extra heavy pipe has been welded with great success for the New York Central & Hudson River R. R. in a hydraulic transmission line, showing absolutely no leakage during a test of ten hours under pressure of 3,000 lbs. per sq. in. This pipe line was laid in a ditch by the side of the track and the work was carried on without interruption with the main line trains of the New York Central passing on the nearest tracks. Considerable welding by this process is also being done in New York City on the service lines of the New York Steam Co., carrying steam under pressure through the streets.

Applications in Iron and Steel Casting.

It would not be possible to enumerate all the smaller special applications which occur from time to time where either the heat produced at

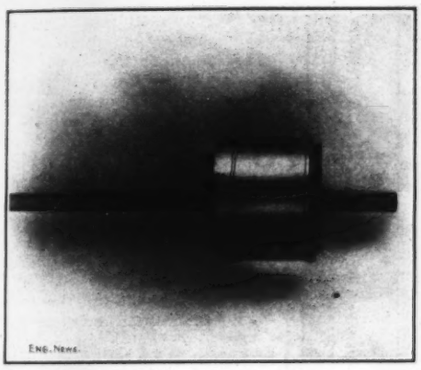


Fig. 10. Two Thermit Welds on One Spoke of a 24-Ft. Fly-Wheel.
(This repair was made at Sylva, a remote village in North Carolina.)

a moment's notice or the superheated liquid steel can be employed to good advantage, but it may be useful to call attention to the fact that as the temperature of the reaction is considerably higher than that of liquid steel and, therefore, very much higher than that of liquid gray iron, there are numerous instances where this increase of temperature offers substantial advantages in the operation of steel and gray iron foundries. Any foundryman familiar with the properties of Thermit would probably be struck with the possibility of using this material in order to increase the temperature of his liquid steel at points where he most needed hot metal.

LARGE CASTINGS.—In making long, heavy and intricate castings, the greatest anxiety is caused by the liability of shrinkage cavities just below or in the neighborhood of the risers. These are due to the metal at that point chilling more rapidly than the body of the casting. In order to counteract this tendency, it is necessary to keep the temperature of the metal in the riser at least at the same point as that in the body of the casting and this result can only be obtained by making the riser very large or feeding it. It is obvious that a saving can be obtained by the use of Thermit under such circumstances. By applying it to the neck of a riser it will so raise the temperature of the metal therein that a free circulation will continue, gases will escape and the tendency to shrinkage cavities will be successfully combated. For this purpose, the Thermit is placed in cylindrical cans so constructed that an iron rod can be run through a sleeve in the middle of the can. The idea is that the heat of the surrounding metal will start the reaction and will prolong it on account of the slag forming a protecting layer inside the can itself. Of course, the effect of this reaction of a small quantity of Thermit on a comparatively large quantity of metal is not of a permanent nature and will affect only that metal immediately surrounding it. The physical force of the reaction, however, must not be lost sight of, as it has the effect of poling or stirring up the metal, if not too sluggish, in its vicinity and so make it more receptive for the fresh metal which has to be added from the ladle.

SEMI-STEEL.—The idea of using such cans in order to increase the temperature of the metal suggested itself for other purposes, particularly in the making of what is called semi-steel, that is, gray iron strengthened by an admixture of steel scrap. The production of this material in the furnace offered difficulties, as the scrap was liable to be burnt up, and it was thought that by pouring hot metal on to scrap in the ladle, the scrap itself being red hot, an amalgamation between the two could be obtained by the aid of a Thermit can reaction. In compliance with this requirement, so-called semi-steel Thermit cans are supplied which are utilized also in cases of emergency in order to increase or maintain the temperature of the iron in the ladle.

Metallurgical Uses.

The mixture in these cans is always composed of iron oxide and aluminum, but the principle of the reaction is by no means confined to iron oxide. There are a number of other metallic refractory oxides which are available. In foundry practice in particular, there is in use a titanium Thermit consisting of titan iron oxide and aluminum. The titanium has a great affinity for nitrogen, which is a harmful ingredient in both iron and steel. By the use of this titanium Thermit in cans, as described above, a reaction is produced under the surface of the metal which allows the nitrogen to combine with the titanium, forming a cyanonitride of titanium. No titanium enters the composition of the metal, as it is all absorbed by the nitrogen. The reaction will greatly purify the iron by allowing gases to escape. Moreover, the iron will flow much more freely and on cooling the casting will show a much denser grain, being particularly suitable for castings exposed to hydraulic pressure, such as pump cylinders and valves.

Other refractory oxides treated by the aluminothermic method are those of chromium, manganese, molybdenum, nickel, vanadium and boron, which metals and their alloys are produced in a high degree of purity and, on account of the temperature of the reaction, entirely free from carbon. Chromium is being used in the United States as well as abroad in all the best brands of high-speed tool steel. Manganese is of great importance in the manufacture of non-ferrous metals as a deoxidizer and will alloy with copper, tin, zinc, aluminum, etc. In the form of manganese bronze, it can be utilized for castings having a high resistance to heat and for that reason has been used in locomotive fire boxes. All these metals command a very high price on account of their uniformity and purity. While competing with similar products made in the electric furnace, they are in a class by themselves, for the reason that the former suffer from the inability to uniformly control the carbon content.

It may be confidently expected that the wonderful energy so mysteriously created by the alumino-thermic reaction will find further development as the experience is made available to ever widening circles of scientific and technical investigators. In all its applications it has done pioneer work and has materially contributed to industrial progress.

NATURAL GAS FUEL is reported as used for the locomotives of the Texas, Arkansas and Louisiana Ry. The gas is carried in a tank on the tender, sufficient tank capacity being provided for six hours' run. The road has two locomotives and one car, and is credited with eight miles of track.

Report of the Flood on the Zuni River, Sept. 6, 1909.

By H. F. ROBINSON,* Assoc. M. Am. Soc. C. E.

During the last ten days of the month of July, all of August and the first six days of September, 1909, the rains on the drainage area of the Zuni River, New Mexico (see sketch map), were quite heavy, but were not general over the whole tract, being more in the nature of heavy showers, approaching, at times, what are termed cloudbursts.

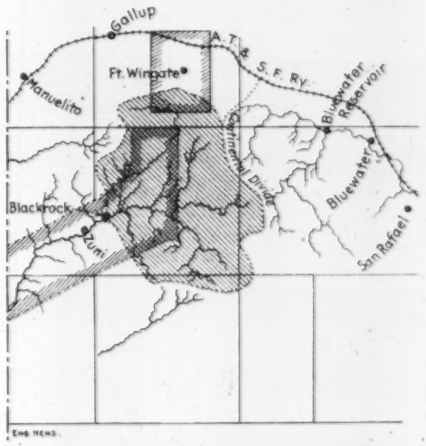
The Weather Bureau stated in its summary for the month of August:

> For the district (No. 9, in which the Zuni drainage is situated), as a whole, the month was the wettest month since the beginning of the record, and was even more remarkable for the abnormal distribution of the rainfall than for its intensity.

For the entire Little Colorado Basin the average was 1.782 ins. above the normal.

These rains culminated in heavy discharges on both sides of the Zuni Mountains on Sept. 5 and 6. On the afternoon of Sept. 6 the Bluewater Dam on the east slopes of this mountain range was destroyed, and within a few minutes of the same time the water undermined the mesa on the south end of the Zuni Dam, on the west slopes, partly wrecking the reservoir.

Records were kept of the amount of water flowing into the reservoir by observing gage



Sketch Map of Drainage Area of Zuni Reservoir, New Mexico.

heights, the capacity of the reservoir at all depths being known. During the period from July 20 to Sept. 6, there was impounded 9,540 acre-feet of water.

The drainage area of this stream above the reservoir is 650 sq. mi. at elevations varying from 6,300 ft. at the reservoir to 9,200 ft. on the tops of the mountains, which form the continental divide.

No records of rainfall are available within this drainage area, the nearest one being at Zuni, below the dam site, at Fort Wingate some 35 miles northeast of the dam, and at Manulito, about the same distance northwest, and all at an elevation of about 6,300 ft.; the latter two being on other drainage basins. On the east side of the divide we have records from Bluewater Station, Bluewater Reservoir and San Rafael. The rainfall on the mountains was undoubtedly heavier than at these lower elevations.

An effort has been made to arrive at some conclusions regarding the relation of the run-off to the rainfall, using the available records, but the nature of the country and the peculiar conditions of heavy rains in one section and no precipitation in others a few miles distance makes it impossible to arrive at any conclusion.

The points where the records were kept, on the west of the divide, form a triangle practically 30 miles on a side in an air line, though a third longer by any road, and there is nothing in the rainfall records to indicate a general storm of similar intensity at any time during the period.

*Superintendent of Irrigation, U. S. Indian Irrigation Service, Albuquerque, N. Mex.

On days when rain was recorded at all three points the precipitation would vary greatly—as on Aug. 2: Manuelito, 1.05 ins.; Fort Wingate, trace; Blackrock, .35; or as on the 29th; Manuelito, .50; Fort Wingate, .20; Blackrock, .20; and on Sept 6, Manuelito, .01, Fort Wingate, 1.20, and Blackrock, .46. On these same dates, on the east slope of the mountains we find:

Aug. 2 Bluewater 0.0; Bluewater Res. 0.0, San Rafael 0.0
" 29 Bluewater .12; Bluewater Res. 0.0, San Rafael .96
Sept. 6 " record lost; " T, San Rafael .70

The accompanying table gives the rainfall at these six points, together with the inflow into the Zuni Reservoir.

The rains began about July 20, and there had been no flow in the Zuni River for some time previous to this date. A heavy rain was recorded at Fort Wingate on the 20th, and on the night of the 22d and the day of the 23d the amount of water impounded was 1,160 acre-feet.

As showing of how little value the existing rainfall records are in this connection: on the 25th and 26th, each, there was rain recorded at the Fort of .2 ins., but there was no flow into the reservoir. There was no further rainfall recorded until Aug. 1, but that day there was an increase of water in the reservoir of 320 acre-feet, showing a local rain in the drainage area.

I have been unable to see any relation between the precipitation at these stations and the run-off, and consequently we must assume that there *is* little relation between them and the rainfall on the drainage, at least for the short period under consideration.

Probably for a period of years some such relation could be discovered were the records available.

The table will show day by day the amount stored in the reservoir, and will give the *average* run-off for the day, but no records were kept that will show the actual flood and its fluctuations.

On Sept. 5, following several days rain in the mountains, the run-off measured 540 acre-feet.

TABLE OF PRECIPITATION NEAR ZUNI RESERVOIR, NEW MEXICO, BETWEEN JULY 20 AND SEPT. 6, 1909.

Date. July	Blackrock.	San Rafael.	Bluewater Reservoir	Bluewater Station.	Fort Wingate	Manuelito	Increase in contents Zuni Reservoir, acre-feet.
20	.02	...	...	.24	.40	.35	...
21	.03	.14	...	...	.10	.20	...
22	.04	...	.35	...	T	.10	...
23	.05	1.38	...	...	.40	...	1,160
24	.07	.06	...	...	.10	.70	...
25	.20	...	...	.05	.40	...	...
26	.20	.30	...	...	...	...	...
27	...	...	T	...	...	...	...
28	...	...	...	...	...	...	...
29	...	...	...	...	...	...	...
30	...	...	...	...	...	.01	...
31	.20	...	.15	...	...	...	...
Aug.							
1	...	.51	.71	.30	.10	.15	320
2	.35	...	...	...	T	1.05	...
3	.29	.29	T	.18	...	...	20
4	.35	.82	...	...	.20	.10	280
5	.28	.17	...	.13	.20	...	440
6	...	...	...	...	.50	T	380
7	.09	...	.20	...	.20	.50	...
8	...	...	...	...	.10	.35	50
9	.13	...	...	.27	.20	.20	60
10	.10	...	...	.04	...	.70	...
11	.04	1.52	T	.05	T	...	200
12	...	1.18	T	.48	T	.20	...
13	T	...	...	...	...	...	...
14	.08	.50	.50	...	...	...	50
15	T	...	...	...	T	...	...
16	T	.74	.32	...	.50	...	360
17	.01	.10	...	.28	.10	...	80
18	.06	.60	.18	...	.20	...	180
19	.02	.76	.22	.38	T	...	820
20	T	...	...	...	.30	...	100
21	...	.90	.62	.28	T	...	900
22	T	...	.29	...	...	.50	180
23	.63	...	T	...	.20	3.00	20
24	.07	...	...	...	...	...	780
25	T	...	T	.37	1.30	...	80
26	T	.44	T	.58	.50	...	...
27	T	...	.03	...	.20	...	20
28	T	.45	T	...	T	...	...
29	.13	.90	...	.12	.20	.50	...
30	.20	...	...	.63	.20	.30	...
31	...	...	.66	...	...	...	...
Sept.							
1	.03	.18	T	...	.40	.50	...
2	...	...	...	...	...	...	260
3	.04	.38	.03	...	.32	...	...
4	.20	...	.91	...	1.20	.50	...
5	.60	.88	.42	...	.50	.20	340
6	.46	.70	T	...	1.20	.01	2,260*
	4.57	14.03	6.04	5.00	10.31	10.10	

*To 4 p. m., when Zuni Reservoir failed. Bluewater Dam went out at practically the same time.

Between dark that day and daylight the next morning the run-off was 1,400 acre-feet; by noon there was 540 additional ft. accounted for, and between noon and 4 p. m., when the failure of the mesa occurred, 280 acre-feet more, or a total of 2,260 acre-feet in about 21 hours.

This so-called failure of the Zuni Dam has thus been described by James D. Schuyler, M. Am. Soc. C. E., Consulting Engineer, of Los Angeles, Cal.:

The extraordinary rupture and subsidence of the mesa adjacent to the Zuni Dam on the south side, as the result of leakage through the basaltic cap rock, which occurred Sept. 6, 1909, after the reservoir had filled almost to overflowing, produced a complete wreck of the spillway, with its fine masonry side walls, and within a week had permitted to escape about one-half the contents of the reservoir. This accident has attracted widespread attention among engineers, as it is quite without precedent in the annals of hydraulic engineering. The foundations of dams sometimes give way underneath the superimposed structures, but it is quite a novel experience that a dam and its foundations should remain intact while the adjacent territory forming its abutment at highest level should prove so unstable as to sink from 4 to 9 ft., and leak to the extent of 5,000 cu. ft. per sec. around the end of the dam, when it had appeared to be particularly sound, solid and water tight.

A fairly complete report of this failure was given in Engineering News of Dec. 21, 1909.

A Reinforced-Concrete Pumping Cistern Put Into Place in the Ground.

By W. DEWITT VOSBURY.*

There has recently been constructed as part of the equipment of the new artesian water works system for the Borough of Haddonfield, N. J., a reinforced-concrete pumping cistern which was sunk into its place under ground by the alternate process of building the concrete wall, excavating the interior earth and sinking the wall already built, continuing the cycle until the proper depth was reached, when a concrete bottom was placed.

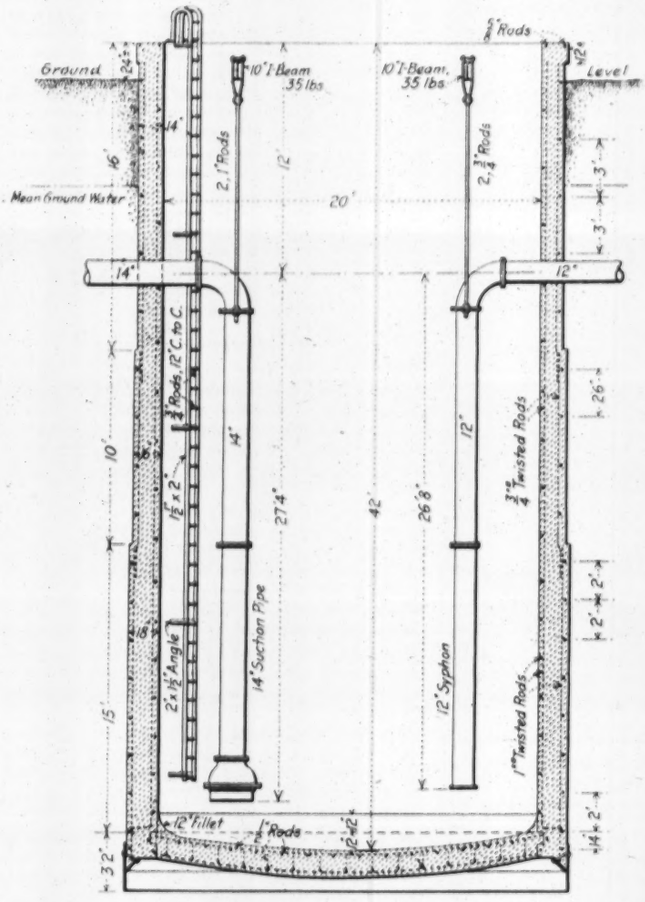


Fig. 1. Vertical Section.

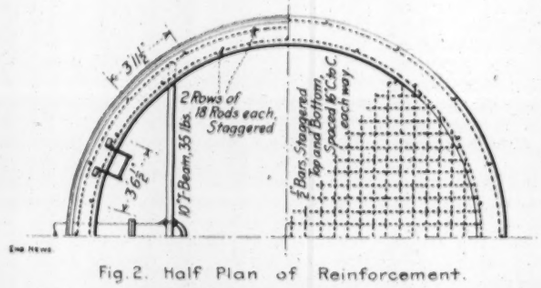


Fig. 2. Half Plan of Reinforcement.

FIGS. 1 AND 2. PART PLAN AND SECTION OF REINFORCED-CONCRETE CISTERN, HADDONFIELD WATER-WORKS, HADDONFIELD, N. J.

Fig. 1 is a vertical section of the cistern and shows the general dimensions and the arrangement of the rods used for reinforcing the wall and bottom. As may be seen on the drawing, the cistern has an internal diameter of 20 ft. and a maximum depth of 42 ft. The shell at the top has a thickness of 14 ins. which is maintained to a depth of 16 ft. where it increases to 16 ins. and again at a depth of 26 ft. to 18 ins. This increase in thickness is made on the outside.

The bottom is 16 ins. thick and is concave, conforming to the surface of a sphere having an approximate radius of 32 ft. This form of bottom was adopted as one which would best resist the upward pressure exerted by the ground water when the cistern is empty and at the same time offer an excellent opportunity for bonding to the wall. The connection between the bottom and wall is a form of tenon joint and is shown in detail by Fig. 3.

The shell, or wall, is reinforced by a network of vertical and horizontal rods. The vertical reinforcement being composed of two eccentric rows of 1-in. and ¾-in. twisted steel rods, spaced approximately 48 ins. c. to c. in the outer row and 42 ins. c. to c. in the inner. The rods of one row are staggered with the rods of the other. The horizontal reinforcement is made up of rods of the same size bent into rings or hoops of the requisite diameter. The ends have a lap of 30 ins. and are securely clamped together. There are two sets of horizontal bars, each set encircling one of the sets of vertical bars. The outer and inner rings are staggered one with the other and are spaced at vertical distances, varying from 24 ins. c. to c. at the bottom to 36 ins. c. to c. at the top.

As shown by Fig. 2, the reinforcement for the bottom is composed of an upper and lower set of ¾-in. rods. The rods of each set are spaced on 16-in. squares and are staggered top and bottom. Two rings of 1-in. rods are embedded in

*Associated with George Pfeiffer, Jr., Civil and Mechanical Engineer, Camden, N. J.

the concrete at the joint between the bottom and wall for the purpose of taking up the arch thrust produced by the bottom.

Forms.

In lieu of the usual form of wooden shoe commonly employed in caisson work an all-steel shoe was adopted. This shoe was constructed of ½-in. steel plates and was built in four sections with double riveted butt joints. A section of same is shown by Fig. 3.

The concrete wall of the cistern was cast in a set of stationary, cylindrical forms, simple in

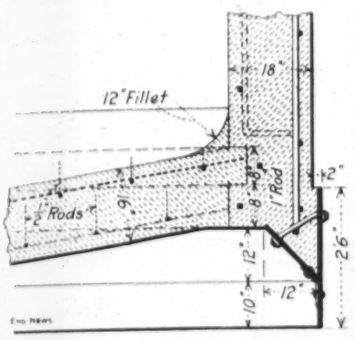


Fig. 3. Details of Connection Between Side Walls and Bottom of Cistern.

design and construction. They consisted of an inner and outer ring, each being divided into six equal segments. Four bolts were used to clamp each segment to its neighbor. Each ring was 5 ft. 6 ins. in height; the inner having an external diameter of 20 ft. and the outer an internal diameter of 23 ft. Four 1-in. suspension rods were passed from the bottom through the top of each ring to a fixed point of support above. This support consisted of four heavy timbers placed crosswise of the excavation and in the form of a square. They were rigidly braced and served to support the forms at a fixed elevation. The top of the forms was kept at approximately the ground level.

The concrete was composed of a 1:2½:5 mixture, with all stones crushed to a size no larger than a ¾-in. cube, crusher-run stone being used. The concrete was mixed very wet, an effort being made to secure as dense a mixture as possible. The concrete was not tamped, but was worked with a spade to release the air bubbles and to cut the stones away from the surface of the forms. No waterproofing compound was used, dependence in obtaining a water-tight structure being placed in a dense concrete. The work of mixing and of placing the concrete was at all times under the immediate supervision of a competent inspector.

Construction.

The work of constructing the cistern consisted of two primary operations, namely, the placing of the concrete and the excavating, one alternating with the other. The first step was to clean away to a depth of several feet a deposit of extremely soft marsh mud. As soon as this was done the steel shoe was assembled and set into position. The forms were then suspended directly over the shoe in the way already described. The rods for the vertical reinforcement were next set and held in their position by means of wooden guides nailed to the top of the forms; the bottom ends of the rods being bent and hooked under the bolts passing through the shoe, as shown by Fig. 3.

From the mixing platform, the concrete was wheeled and dumped into the forms where two laborers were employed in spreading and cutting down the concrete as fast as it was delivered. The horizontal reinforcing rings were set and wired into position as rapidly as fresh concrete reached the proper height. Each 5-ft. course was made monolithic by continuous concreting in one day's work. The work of excavating was carried on while the concrete was setting, the excavated material being raised to the surface by means of a derrick and engine hoist. It was found that, even though the earth were excavated from beneath the whole cutting edge of the shoe, the cistern would not settle until the forms were released. The friction exerted by the forms combined with that of the earth pressing against the sides of the cistern was sufficient to hold the cistern in suspension. This was of great advantage, as it made possible the resumption of the excavating soon after the completion of a ring of concrete. Had this not been the case it would have been necessary to wait before resuming the excavation until each freshly cast ring of concrete had attained a considerable portion of its working strength before allowing the cistern to sink and the new concrete to be subjected to the external earth pressure.

Two nights and the intervening day were usually allowed for the concrete to set. At the end of this time the bolts clamping the segments together would be released and the forms disengaged. The cistern would then settle slowly into the excavation, which, if not already sufficient, would be carried down to the proper depth. This depth was such that when the cistern had come to rest there would be remaining approximately 6 ins. of concrete in the forms. The bolts holding the segments together would then be tightened, such openings as existed between the forms and the concrete stopped up with soap and the operations above described repeated. In this manner the cistern was sunk to the final depth and the concave bottom built in. At no time was serious difficulty experienced with the structure holding up or keeping the same in perfect alinement. The rigid position of the forms undoubtedly aided in the latter to a great extent. Although no waterproofing was used the wall and bottom presented upon completion a uniformly dry surface.

In designing the cistern, consideration had to be given to the fact that during the operation of sinking the upper portion of the concrete wall would be subjected to earth pressure before sufficient time had elapsed for it to attain its full working strength. Possible strains due to unequal settling was another factor to be taken into account and these, coupled with the fact that it was necessary to retain a certain amount of weight to cause the cistern to sink, limited the allowable minimum thickness of the walls. For the above reasons it was found necessary to adopt a heavier design than would have been required to resist the simple earth and hydrostatic pressures upon completion.

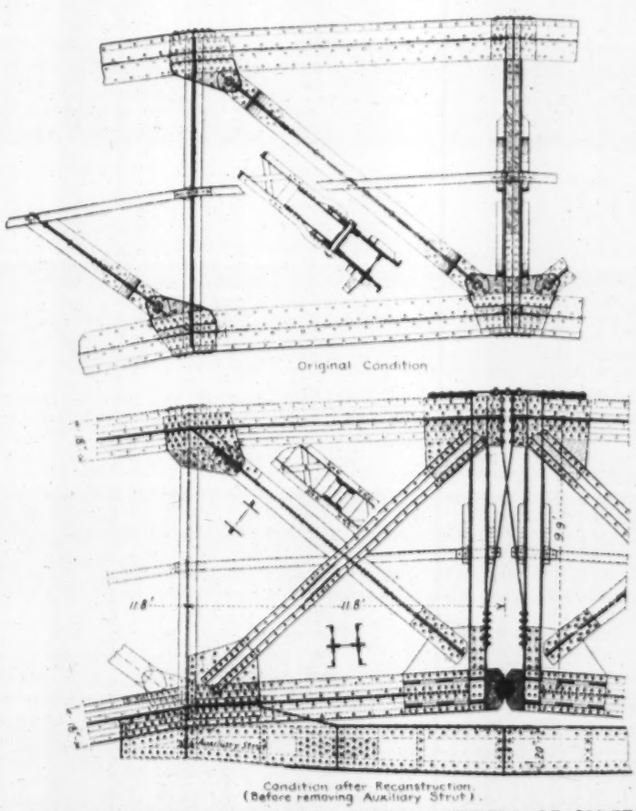
The above is the second of two cisterns recently constructed from the same general plans and specifications by Geo. Pfeiffer, Jr. In each instance the results obtained from the use of reinforced concrete have been highly satisfactory. The cistern described in this article was completed, including roof, ladder and other minor accessories, for the sum of $5,190.

An Unusual Bridge Job: Putting a Center Hinge in a Two-Hinged Steel Arch.

A two-hinged braced arch bridge of the Anatolian Railway between Ismid and Angora, Turkey, of 236 ft. span and 64.6 ft. rise, c. to c., was changed by adding a center hinge, without interrupting traffic during the work. An illustrated description is given by E. Baehr, of Constantinople, in "Zentralblatt der Bauverwaltung" of July 23, 1910. It seems that some of the members had buckled in service, and the defect was attributed to improper connection of the arch in erection (the two-hinged arch being a constrained framework). It was decided to relieve the excess stresses by breaking the continuity at the crown, inserting there a center hinge. The drawing herewith shows how this unusual piece of work was carried out. The upper sketch shows the crown portion before the change, the lower sketch the same after the change but before the temporary crown strut was cut away.

The work was done from a staging hung from the arch at the crown. To take care of the crown thrust until the new hinge connection was in, a strut was riveted across the two middle panels of the lower chord, as indicated in the lower sketch. Gusset plates were then attached to the chords diagonals meeting at the center of the upper chord, and the diagonals were slipped through the existing diagonals in sections and were riveted up. Then the old diagonals in the two middle panels were cut out, as well as their gussets, leaving room for cutting apart the lower chord. The latter operation was followed by inserting the two new center posts, building transverse sway frames and trussed floorbeams in the plane of each post, and seating the stringers on the new floorbeams. This left the center post and its floorbeam and swaybracing free to be removed, which was done by cutting its connection to the top chord. Then the space in the lower chord for the hinge blocks was cleared out and the blocks were dropped in. With the pin between, the two blocks were clamped together, to eliminate lost motion, and then the rivets connecting them to the chord webs were driven. New diagonals were then put in the middle panels in place of those removed.

The remaining work was to place new lower laterals, cut through the top chord, rivet slotted



ORIGINAL AND RECONSTRUCTED CROWN PORTIONS OF 236-FT. STEEL ARCH BRIDGE ON ANATOLIAN RY., ASIA MINOR.

cover-splices over the separation, and attach the crossed vertical hangers shown in the drawing to assist in transmitting shear. This completed the reconstruction and the auxiliary strut was thereupon removed, except that its gussets were left attached to the lower chord as reinforcing plates, the projecting parts only being chipped off.

Cracks in the Concrete Core-Wall of the Little Bear Valley Dam, California.

Quite recently a number of Western newspapers have contained some very sensational accounts of the failure of the concrete core-wall of the earth dam now being built in Little Bear Valley, near San Bernardino, Cal., for the Arrowhead Reservoir and Power Co. In investigating these reports we found that they were based on some facts but that they were much exaggerated. In order to give a correct statement of the trouble we are very glad to reproduce below the salient portions of an explanatory letter from Mr. W. H. Sanders, M. Am. Soc. C. E., who was called in to report upon the occurrence.

The design of the dam and progress made in construction is shown in the accompanying figure. The core-wall is constructed of concrete and up to the present height without reinforcement. Its bottom width is 20 ft. and top width when completed is to be 3 ft. The work progressed throughout the year 1904 and the following seasons and the structure is not yet completed. In the latter part of October, 1905, Messrs. F. C. Finkle and F. E. Trask were retained in an advisory capacity as Consulting Engineers to the engineers in charge of the works. Owing to certain difficulties which arose in regard to the construction of the dam, principally the core-wall at that time, they have served as Consulting Engineers, first with Mr. E. H. Kellogg, who remained in charge as Chief Engineer until Jan. 1, 1908, and from then until May, 1910, with the resident engineer, who was Mr. Kellogg's assistant.

On Oct. 31, 1910, the engineer in charge advised the Consulting Engineers that four fractures had appeared in the core-wall. At that time the top of the core-wall was about 4.8 ft. thick at an elevation of 155 ft. above the stream bed, with a length of 740 ft. The top of this wall was 36 ft. above the earth fill on the downstream side and 31 ft. above the fill on the upstream side.

The Consulting Engineers visited the dam on Nov. 1 and 2, 1909, and made an examination of these fractures. They also gave instructions to the engineers on the work as to the necessity and character of the observations required for a complete knowledge and study of the conditions that had developed. They requested daily observations as to level and alinement of the top of the core-wall together with the calibration of the cracks in the core-wall. Their own personal observations at this visit located crack No. 1, 113 ft. south of the north end; crack No. 2, 196 ft. south of the north end; No. 3, 424 ft. south of the north end; and crack No. 4, 640 ft. south of the north end. The total length of the top of the wall at this time was 760 ft. On Nov. 1, crack No. 3 was calibrated and had a width of 0.009 ft. At the same point on Nov. 8 the width was 0.01 ft, on Nov. 18 the width was 0.014 and on Dec. 13 the Consulting Engineers were advised that the width of the crack was about the same. From Nov. 7 to 18, the three cracks nearest the middle of the core-wall increased from 0.001 to 0.006 in., and when the temperature fell from an average of 65° to 30° F. during the fall of 1909 the cracks increased from 0.002 to 0.035 in. When the sun was shining on one side of the wall, the cracks would diminish slightly in width, and when that side of the wall would be shaded they would increase slightly in width. As the wall extends almost due north and south this condition was readily observed and applied to both sides. On Nov. 19 the fifth crack appeared in the wall, also running vertically from top to the earth fill.

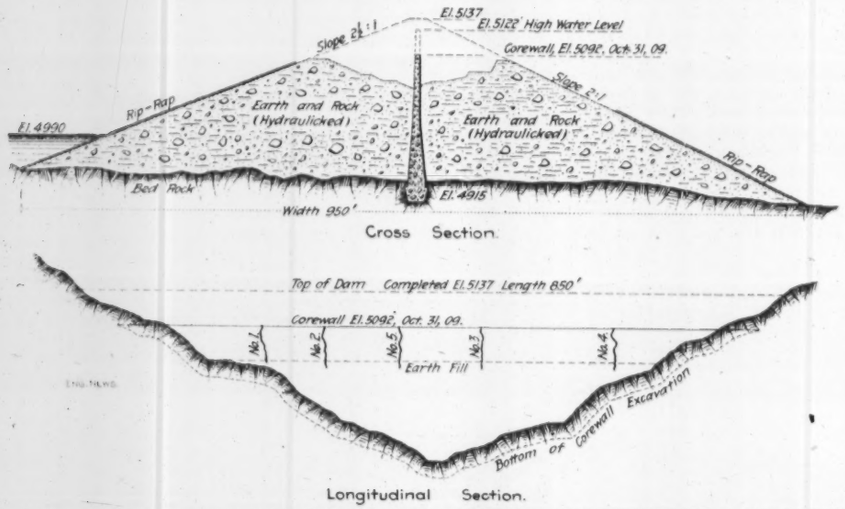
The engineering force made daily observations throughout November and up to Dec. 13 and reported no change in either level or alinement of the top of the core-wall. At that time the Consulting Engineers decided that the Assistant who had had constant charge of observations could be dispensed with and that the resident engineer on the work should keep weekly records until further orders. About April 4, 1910, the Consulting Engineers learned that the resident engineer had not kept up the records and measurements upon the wall and they directed that he proceed to do so. On April 5 this engineer reported the wall to be out of alinement 6 ins. at the maximum point. On April 8 the Consulting Engineers visited the dam and made a personal and instrumental observation and found that the line laid out on top of the wall for purposes of recording lateral movement had been marked only by lead plugs sunk in top of wall at points about 40 ft. apart and that no record or reference work had been done to tie these points into the center line used during construction purposes, also that no measurements had been made to tie these lead plugs to one another. Consulting Engineers Finkle and Trask then examined carefully the wall, took careful records as to the location of these lead plugs and referenced them to the sides of the wall as well as to the abutments. They visited the works again May 1 and 2, also accompanied by Mr. Sanders on May 20 and 21 to the dam, and checked the former observations. These surveys developed the fact that the core-wall was not changing laterally—since the observations by the Consulting Engineers, neither had it changed in elevation. While the vertical cracks were changing slightly in width[illegible] changes were conforming strictly to chang[illegible] temperature from day to day. These ob[illegible]tions caused Mr. Finkle and Mr. Trask to [illegible] the reliability of the observations made b[illegible] resident engineer, with a result that a new [illegible]dent engineer was appointed. The new re[illegible] engineer is making careful observations, [illegible] to date show that there has been no mov[illegible] of any consequence in the wall.

As this is a core-wall in an earth dam it s[illegible]ld be evident that the utmost care in rega[illegible] to alinement was not observed during constru[illegible]n.

In November, 1909, pits were excavated a[illegible] two of the cracks and it was found that the c[illegible]ks ceased to exist at a depth of about 6 ft. [illegible] the surface of the earth fill.

Pits have been sunk at all of the cracks to de[illegible]termine their depth. This examination s[illegible]ows that all the cracks pinch out a short distanc[illegible] below the surface of the earth fill. All the data gathered to date indicate that the cracks may be classified as temperature cracks.

The design of the dam was made by the late H. B. Hedges, then Chief Engineer of the [illegible]mpany.



SECTIONS THROUGH LITTLE BEAR VALLEY DAM, NEAR SAN BERNARDINO, CAL., SHOWING LOCATION OF TEMPERATURE CRACKS IN CORE-WALL.

Rain at Panama.*

The rainiest July of record on the Isthmus was that which has just closed. There were showers on each of the 31 days, and some of the most violent of these occurred during hours when work was in progress on every section of the Canal and railroad. A popular deduction from past rainy seasons is that there is likely to be a heavy shower between 12 and 2 o'clock each day, and the meteorological records on the Isthmus sustain this belief, to the extent of showing that the noontime rains are very frequent and often heavy, as much as two inches of rain falling in one hour.

At Gatun during the hardest part of such a storm, one who looks out across the valley from the division office can see but dimly the lock monoliths and the cableway towers nearby, while the workers on the Dam beyond the locks are quite obscured from view. Gradually the more intense rain gives place to a gentler downfall, and it often happens that within half an hour after the blinding shower the sky is blue and the sun is shining. To one who watches from shelter it is a fair assumption that during the most violent part of the rain the men have found some protection and the work has been temporarily suspended. He can see that this is not true during the drenching but gentler parts of the storm; and if he were out on the Dam, at the spillway, or in the lock site, he would know that the work seldom ceases during any part of the rain.

The men at work on the toes of the Dam cannot shift track so rapidly in wet as in dry weather, and there is an added inconvenience in the dumping of rock and earth from the spoil trains, but they can do some work and, while they can, they do it. In a locality like Gatun, where rain is the rule and fair weather the exception, this persistence through the heaviest showers makes a great difference in the amount of spoil that can be unloaded on the toes of the Dam, and it explains in a measure why that work is keeping pace with that on the Locks. Showers make no difference to the force on the hydraulic fill, because the dredges and relay pumps are under cover, and at the spillway it is not allowed to interfere; the men put on their waterproof coats and keep at work.

Half of the concrete work at the Locks is also done under cover; that is, the materials are sent to the mixers, mixed, and delivered over the lock site by men protected from the rain. They set the pace for the outside workers. Concrete is spaded into place as long as the cableway operator can see the signals of the man whose flag directs the movement of the buckets, and all the rest of the work moves in consonance with this.

One of the wettest places in Culebra Cut is the pit in which a steam shovel works, because the pit is filled knee-deep with water, and there is no protection overhead. The pitmen are laborers, usually negroes, and they pay as little attention to the rains as the Spanish track laborers, and the white Americans who direct the work. A statuesque picture of indifference to weather is the conductor of a spoil train running out of Culebra Cut. The engineer and firemen are in the locomotive cab and dry, but the conductor is entirely exposed during the heaviest storms, as he sits on the high side of the rear flat car of a train carrying spoil to the dumps or running back to the Cut where some steam shovel is waiting for more cars. It is an unusual storm that forces a steam shovel to suspend, unless the drainage of the pit is stopped and the water puts out the fires. The track gangs keep at work in the Cut and on the dumps where the mud is literally up to their knees, because dispersing of the spoil, not excavating it, is still the determining factor in the digging of Culebra Cut.

*From "The Canal Record," Aug. 3, 1910.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.
220 BROADWAY, NEW YORK

BRANCH OFFICES
CHICAGO: 1636 Monadnock Block
BOSTON: 43 Tremont Street
WASHINGTON, D. C.: Home Life Building
SAN FRANCISCO: Monadnock Building
RUDOLPH MOSSE, BERLIN AND HAMBURG, GERMANY
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Entered at the New York Post-Office as Second-Class Matter.

Probably no country in the world to-day is the scene of such activity in railway construction as is China. Just as in the period following the War of the Rebellion the transcontinental railways of this country sprang into existence with almost uncanny rapidity, so to-day in China the whole of its vast storehouse of mineral and vegetable treasure is being opened to the coast ports by new roads. The fight for the control of these railways has involved all the powers of the world. Five companies from as many European countries and one from Japan already have had their fingers in this huge financial pie, and even now one of the most delicate questions before our Department of State is concerned with the interests of some American capitalists in another international combine with a new Chinese railway as the prize.

In all this struggle for the direction of the transportation of what is proving to be one of the wealthiest countries of the world, there has been a disposition to disregard the native Chinaman as a factor, except in so far as his sturdy coolie body could serve construction or his devious mandarin mind might control concessions. Originally held by the financiers and engineers intimately connected with the development, this idea has been easily accepted by the lay public and even by those engineers who have had no personal concern in the work. It was, then, with considerable surprise that the news of a Chinese railway financed and built by native talent was received some years ago. As with Dr. Johnson's dog walking on its hind legs, men were surprised not that it was done well but that it was done at all. This occidental, or perhaps Caucasian, condescension is inherent and can only be removed by first-hand observation; those Americans and Europeans who visited the Peking-Kalgan railway, or its extension described on another page of this issue, soon came to realize that the Chinaman could build railways and, what is more, build them well and cheaply.

Every college man can remember in his class some shrewd Oriental who through the mazes of a foreign tongue managed generally to keep abreast of his sometimes more facile but never more earnest fellows. Probably every engineering school in this country and not a few in the old country, have annually sent these men back to their homes to leaven the whole lump; it is no great wonder that the training is beginning to tell. Any American road would be hard put to it to show a keener looking lot of men than the engineers of the Peking-Kalgan extension shown in the photograph on p. 192 of this issue.

We recommend to American engineers Prof. Dobbin's description of the latest native-built railway in China, not so much for what they will learn in an engineering way, for there were no great difficulties to be overcome, but rather to widen their horizon, and to make more liberal their views, to show them that off on the other side of this globe yellow men in queer costumes are working out the same problems as are we, and apparently are doing it equally as well.

A bold step forward in the application of the internal-combustion engine to marine work is reported from Hamburg, Germany, as briefly noted in Engineering News, July 28. It is announced that the shipbuilding firm of Blohm & Voss is at work upon a 9,000-ton freight-carrying steamship which is to be fitted with two Diesel oil engines of 1,500 HP. each. The vessel will be designed to develop a speed of some 13 knots per hour. In the first cable despatches it was strangely reported that the vessel would be driven by gasoline motors. This statement has now been corrected. No particulars as to the design of the engine are available, but it may be surmised that the Diesel two-stroke cycle will be adopted, as has been done on some recent Diesel engines used on vessels of small size for inland navigation, in order to bring down the weight of the engines per horsepower to a reasonable figure. The largest marine Diesel engine reported before seems to be a 500-HP. unit on a British yacht, the "Lady Evelyn."

Perhaps the strongest argument in favor of the Diesel engine, compared with other types of internal-combustion engine for use on shipboard, is its safety from fire and explosion. With any type of engine, using gasoline or other volatile combustible, a certain amount of risk is involved. This risk is a minimum in small vessels for use in smooth water, where the engine room and the gasoline storage can be well ventilated at all times; but the situation is very different on a large ocean-going vessel with its deep engine room and closed compartments. The risk of explosive combustion where even a small amount of gasoline vapor may accumulate in an enclosed space has been shown many times, a notable recent illustration being the explosion in the British submarine A1, which occurred in Portsmouth Harbor on Aug. 6, in which seven men were seriously injured. It may be added that this is the fifth serious gas explosion that has occurred in British submarine boats.

For vessels of large power, the cost of gasoline becomes so great that recent ventures in the use of the internal-combustion engine on seagoing vessels of some size have generally contemplated the use of gas producers so that coal may be used as the fuel. Probably the most serious drawback to this system is the weight and space required for gas producers of capacity sufficient to propel a vessel of large size. Besides this, however, there is a certain element of risk in connection with gas producers, particularly under the conditions which would exist on board a ship. Experience is lacking to show how great or how small this risk might be; but it will scarcely be seriously contended that a gas producer plant can be made as safe from explosion and consequent fire as a marine boiler plant.

The Diesel engine, using a heavy oil for fuel directly in its cylinders, has the great advantage over the gas engine of dispensing with the whole equipment of gas producers, scrubbers, storage tanks, etc. The fuel it uses is the cheapest grade of crude or refuse oil, whose carriage and use involves scarcely more risk of fire or explosion than the carriage of so much coal. Its efficiency, as is well known, is the maximum attained by any heat engine, reaching as high as 30% of the total heat in the fuel used.

Without doubt some difficult problems will arise in adopting this motor in large sizes to the conditions of ocean navigation. The matters of reversing the engines and of speed governing in a storm when the propeller may be out of the water half the time may be suggested by way of illustration. In the case of a cargo steamer destined for tramp service, as this new boat appears to be, some difficulty may arise in securing proper fuel at some of the ports intended to be visited.

There need be no doubt that all these problems will have full consideration by the designers of the new vessel. Her appearance and behavior in service will be followed with great interest in marine engineering circles.

The need of better training for city health officers has been mentioned more than once in these columns. We have also called attention to the fact that in many respects a well-trained sanitary engineer is far more competent to administer the health of a city than a large percentage of the physicians who are selected for that purpose.

The latest illustration of the way in which city health officers who have received nothing but medical training to fit them for their public-health work, and oftentimes not the best of that, comes from a city of perhaps 75,000 inhabitants, located not 100 miles from New York. In the course of the annual report of this health officer expression is given in the following confused ideas regarding infant mortality and sewerage systems and modern methods of sewage disposal.

> There is no doubt that some of this large infantile mortality is due to the horrible condition of our sewers, which should be remedied as speedily as possible. Not, however, by cleaning or other makeshifts, but by the building of one large trunk sewer so located that all branch sewers will easily drain into it.
>
> The sewage should be conducted into a so-called destructor which effectually and profitably disposes of it. Such destructors have been introduced into several American cities, notably Detroit, and have given universal satisfaction.

It would be no wonder if the infant mortality of the city were high when its health-protective work is directed by a man with such an utter lack of knowledge of the principles and the practice of modern sanitation as is exhibited in the foregoing quotation. It is conceivable, but on the whole unlikely, that a small part of the infant mortality of the city in question has some relation to the sewerage system, but very improbable that there is any relation whatever between the method of final disposal employed and the health or mortality of the infant population.

The doctor's confusion of refuse destructors for burning garbage and other municipal refuse and plants for purifying sewage is unfortunately one that is all too common in the medical and in the public mind, but the conclusion reached on these subjects seems inexcusable on the part of a health officer of any city, large or small. However, the language used in the second paragraph of the quotation is subject to various interpretations. It may be fairly assumed that the doctor had refuse incinerating plants in mind. It would be difficult for him to prove that any American city had ever operated one of these plants, and more difficult still to prove such an assertion as related to the city of Detroit which has no refuse incinerating plant.

It is a shame that any American city of 75,000 inhabitants, or for that matter 10,000 or 5,000, should entrust its health-protective work to a man who has no apparent knowledge of the elementary principles of municipal sanitation, and who is evidently not even competent to direct needed measures to bring infant mortality within available means of control.

It is only fair to say that we have not seen the full report of this health officer, so that it is possible that other portions of it show more intelligence than does the one which we have quoted. On this account we refrain from giving the name of either the city or the health officer, but the ideas expressed have been notorious features of so many reports of city health officers in

the past few years that we feel we do no injustice to the medical profession in again calling attention to the fact that, quite contrary to the public notion, medical training still comes very far from fitting a man for the highly important position of city health officer.

It is an open secret that the practice of cement testing in this country to-day is not so advanced as to guarantee uniform results on the same cement by different laboratories, or even by the same laboratory at different times. Some years ago this fault might have been due to carelessness in manipulation, but as the knowledge of it has spread amongst the cement testers of the country we think the care with which laboratory manipulations have been carried on has correspondingly advanced, so that the blame at present rests not so much upon the operators as upon the rules under which they operate.

In Germany, we are quite sure that the complaint of nonuniformity of results is not so prevalent as it is here. This is due partly to the well known care with which German scientific men prosecute their work, and to their unceasing efforts to standardize methods, and largely to the excellent specifications under which they work.

In so far as these specifications can be reduced to short space, we have presented their latest revision on another page of this issue. Accompanying these specifications there are numerous instructions which we do not find space to reproduce, but which to no small degree contribute to the further uniformity of the German tests. An observation of the paragraphs relating to methods of testing will show some reasons at least whereby the Germans arrive at more uniform results than do the testers in this country.

On looking over the German specifications quite evidently the provisions different from the American standard are those relating to the preparation of specimens and the one specifying compression tests instead of the ordinary tensile briquette test common in this country. In preparing the specimens it will be noted that great attention is given to the mixing of the mortar, to the gaging of the water, and finally to the tamping of the specimen. The committee of the American Society of Civil Engineers which reported on the testing of cement stated that the mixing and molding machines which had been brought to its notice had hardly reached a sufficient degree of mechanical excellence to warrant their being recommended for standard use. The mixing machine recommended by the Germans may still fall under this qualification, but it is quite possible that the lack of excellence in the tamping machine was due to the fact that it had to be used on small briquette specimens. When a 2¾-in. sq. surface is to be tamped the machine for doing this tamping is much more easily designed than one in which the typical curvilinear tensile briquette is used.

At the recent meeting of the American Society for Testing Materials the Committee on Cement reported that it had under consideration the adopting of compression tests in the standard specifications for cement. In view of the ease with which these tests are made and of the success with which the Germans are using them, it is certainly to be hoped that the committee next year will bring in such a recommendation. At the same time it might study with considerable profit the revised specifications which the Germans have recently brought out.

Campaigns Against Rats and Other Disease-Spreading Vermin.

Those aggravating pests, the mosquito and the fly, it is now beginning to be generally understood, are not only nuisances in and of themselves but are also responsible for the spread of many of the worst diseases which fall to the lot of mankind. The mosquito spreads malaria and yellow fever and one variety of fly (the Tstete) conveys sleeping sickness, each and all through parasites which are taken into the blood of the insect when it bites a human being and is again imparted to a human host by the bite of the same insect. The common housefly, through its filthy habit of feeding on human dejecta of all kinds, as well as food destined for human beings, first soils itself with the dejecta and then pollutes the food, at the same time carrying to the food any infectious germs which the dejecta may contain.

The mosquito and the fly are small, winged and elusive. Much larger and with quite different means of locomotion and far more readily caught is another kind of vermin responsible for the spread of a dreaded disease. The animal to which we refer is the rat, and the disease which it aids in spreading is the bubonic plague. But the rat does not spread the plague unaided. It is but an intermediary and accidental host which in itself does nothing but harbor the germs of the plague. The real vehicle of infection is a species of flea.

Happily the United States is rarely subject to the plague, but that this disease can gain a foothold in this country has been amply proved by the experiences of the Pacific coast during the last few years. Plague-prevention now centers upon the rat. Elsewhere in this issue we reprint an interesting report on rat suppression at San Fancisco. This work, as the report explains, is now being carried on as a precautionary measure only, as there has been no case of human plague in San Francisco for two and a half years.

Just how the rat and the flea combined are responsible for the spread of the plague among human beings and how the progress of the disease may be prevented, and the disease stamped out, can best be explained by a quotation from Sir Rubert W. Boyce's "Mosquito or Man?", a book far broader than its title, since it deals with all manner of diseases spread by insect pests and vermin generally. The quotation is as follows:

> Plague is caused by a bacillus, that is to say by a bacterial parasite or virus, and belongs to the class of diseases which also embraces typhoid, cholera, tubercle, leprosy. Like all the bacterial diseases, it may be transmitted in various ways, such as by direct contact, by contaminated food and clothing. But there is one special way by which we know it is spread, and that is why we discuss it here, namely by means of an insect—in this case the flea. It has been shown by several observers, notably in 1906 by the investigations of the Plague Commission in India, that especially the rat flea, *Pulex cheopis*, acts as the carrier. It appears that when the flea takes up a meal of infected blood from a person suffering from plague, the bacilli are not killed in the body of the flea; it has been shown that they even multiply; when the infected flea bites a rat or a healthy human being it transmits the virus. The rat flea, it would appear therefore, is the chief transmitting agent, and this explains why the rat in common with man is the greatest sufferer from plague. Epidemics of plague amongst rats often precede those in man, and dead and sick rats have always been regarded with the gravest suspicion in countries liable to plague. These observations therefore teach us that the rat and the particular flea which infests it are the agents which must be regarded as largely responsible for the spread of the disease. And, just as in the case of the mosquito-borne diseases special sanitary measures—the attack, in other words—must be directed against them, so in plague in all anti-plague measures a special war must be waged against the rat. Anti-rat measures are enforced; steps are taken in all epidemics to exterminate them both on ships and in towns. Indeed as a precautionary measure in those places where plague is liable to be introduced, the rats are systematically examined throughout the year, as in Liverpool, to try to detect at the earliest stage an acutely or chronically infected rat. The rats on ships coming from ports where plague is known to exist are of course subjected to very special bacteriological scrutiny; and as a further precaution means are adopted to prevent the rats from such ships getting on shore. By these means, if plague is discovered in the rat the sanitary authority is forewarned, and is able to take effective steps before the disease has attacked man. Again, just as in the case of yellow fever and malaria the essential part of the plan of campaign is to exterminate the anophelines and the stegomyia, so, in the case of plague, the root of prophylaxis is to exterminate the rat, and with it, its own special flea which is the carrier. We see now, moreover, how improved sanitation, better housing, prevention of overcrowding, sewering, and destruction of filth will diminish the natural hunting grounds of the rat, and therefore its flea, and will in consequence lessen the chance of spreading the disease; and this is why plague has died out in places where hygiene is good and survives where there still exist overcrowding, squalor, and dirt.

Those who have not followed the subj[ect] now understand why rat catching at the [rate] 8,600 a month should be still going on [in] Francisco, although so long a time has [elapsed] since a case of plague has been discovered [or] among either human or rat population. [It] also be understood why it is desirable [that] Francisco and other Pacific coast cities [with] stant communication with Asia, the home [of] plague, to enter upon a vigorous campa[ign] rat-proofing.

In the future we shall see in all our pr[ogres]sive cities and towns a considerable amo[unt] work directed against any and all classes [of] min which play a part in the spread of [com]municable diseases. The rat, the flea, s[ever]al kinds of flies and of mosquitoes in various [parts] of the world, the tick in some sections, a[nd] we know not what other predatory members [of the] animal kingdom, will become the sanitary [target] of the health officer. Fortunately for the [prog]ress of these health-protective campaigns [there] are far more generally understood reasons [for] exterminating these pests, since one and all [are] a nuisance which everybody wishes to be rid of. When by means of an educational campaign it becomes generally understood that these pests are agents of death as well as causes of annoyance, vigorous measures for their suppression may be expected wherever the pests exist.

We have already seen what is required for getting rid of rats and their accompanying plague-causing fleas. Systematic drainage, as well as filling in of undrainable places, together with even simpler means for abolishing numerous breeding places near dwellings, will suppress or reasonably control the mosquito. To be practicably rid of flies requires the practice of only the most elementary principles of sanitation and ordinary household cleanliness, such as the proper disposal of stable manure and other organic wastes in which flies breed or upon which they feed. Where insect pests cannot be wholly suppressed resort must be had to screening to keep them out of houses and other buildings and to prevent the access of flies to such privies as cannot be abolished. Rat-proof construction, as we have seen, must in like manner be used where necessary.

LETTERS TO THE EDITOR.

Methods of Showing Rock in Tunnel Sections.

Sir: Referring to the illustration accompanying the article, "Driving the Laramie-Poudre Irrigation Tunnel in Colorado," on page 110 of your issue of July 28, 1910, would it not be a good idea to get away from the

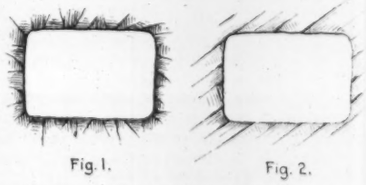

Fig. 1. Fig. 2.

conventional method which you there use for showing rock (the present Fig. 1) and instead to employ the method shown herewith (Fig. 2)?

Emile Low, M. Am. Soc. C. E.
606 Ashland Ave., Buffalo, N. Y., Aug. 4, 1910.

[We aim to indicate stratified rock wherever there is justification for doing so in the sketches or drawings submitted to us. The original from which the illustration in question was prepared showed the conventional symbol for unstratified rock, and this was followed in preparing the illustration for reproduction. Ways of showing the two materials are illustrated on Plate III. of Reinhardt's "Technic of Mechanical Drafting," which is the standard followed by our drafting department.—Ed.]

River and Harbor Appropriations Divided Between New Improvements and Maintenance.

Sir: Referring to your editorial article on "The Future River and Harbor Policy of President Taft" in your issue of July 28, 1910:

The President states that "the chief defect in the bill is the large number of projects appropriated for, and

uneconomical method of carrying on these projects the appropriation of small sums in comparison to amounts required to effect completion." While this statement is true, it has been exaggerated by the press in a way which is unwarranted by the facts.

One feature of river and harbor work which is apt to be overlooked by most writers, except those who are actually engaged in the work, is the necessity for *maintenance* as well as *improvement*.

In railroad work, water-supply, and manufacturing plants, the first cost and cost of maintenance are clearly defined and readily separated, but in river and harbor work this is not the case. Too many persons look upon all of the items in the river and harbor act as appropriations for *improvement* and wonder why so many small appropriations appear in each succeeding act. As a matter of fact most of the smaller amounts are for *maintenance* and not for improvement in the proper sense. They can no more be dispensed with than the section gangs on a railway system.

Take for illustration some of the items from the River and Harbor Act approved June 25, 1910. In the Little Rock Engineer District we find the following items: Black and Current rivers, $19,500; Cache River, $3,000; St. Francis and L'Anguille rivers, $9,500; White River, $17,500. These amounts are required for snagging and are not in the nature of permanent improvement, as the work must be kept up continually and repeated year after year. If not provided for, the obstructions would soon become so numerous and dangerous that navigation would practically cease.

Take as a further illustration some of the items in the St. Paul Engineer District: St. Croix River, $4,000; Minnesota River, $2,200; Red River of the North, $7,500. Here the climatic and geological conditions are different. Very little snagging is necessary but a certain amount of dredging must be done each year to maintain even a moderate depth during the low-water season.

A hasty review of the last River and Harbor Act shows 168 items for "improvement," 135 items for "maintenance," and 122 for "improvement and maintenance," a total of 425 items. Even this statement does not show the whole number of appropriations for maintenance because in many cases the appropriations for "improvement" will be devoted partially to maintenance. For example, the appropriations for the Mississippi River, from New Orleans to St. Paul, amounting to $3,500,000, will be expended partially upon dredging and repairs to existing works.

A tabulated statement issued by the National Waterways Commission on Jan. 1, 1910, shows 203 inland waterways which have been improved by the United States—counting the Mississippi, Ohio, and other large rivers only once. In addition, there are approximately 300 harbors of all classes, which have been improved by the United States, making a total of approximately 500 harbors and waterways. Practically all of these are subject to deterioration; and therefore require appropriations for maintenance, although not necessarily each year.

Reverting to the current River and Harbor Act, we see, then, that while the 168 items for "improvement" might be reduced in number (if each section of the country did not fight too strenuously for its own particular river or harbor), yet the 257 items which are wholly or partially for "maintenance" cannot be reduced in number without crippling the water transportation over large areas, some of which are entirely without other means of transportation.

A greater appreciation of the magnitude of our country and of the extent of its river and harbor works should tend toward a clearer understanding of the subject and should prevent some unwarranted criticisms.

Yours truly,

J. W. Woermann, Mem. Am. Soc. C. E.,
U. S. Assistant Engineer, Western Division.

St. Louis, Mo., Aug. 9, 1910.

[Of course it should be understood that a considerable part of the $52,000,000 included in the last River and Harbor Act is for maintenance. But that does not affect the principles involved in the arguments against "piecemeal work," "log-rolling" and the "pork barrel." In fact, it strengthens the argument, for many of the maintenance items are for the upkeep of "improvements" that never should have been undertaken, and many others for "piecemeal" work "improvements" which have been of little use and never will be of much use until the work as a whole is completed.—Ed.]

A New Applied Science, Perhaps to be Called Civic Engineering.

Sir: If ever we have an applied, constructive political-science, as I hope and believe we may, called perhaps Civic Engineering, it will be due, I believe, in no small measure to your paper's enlightened sense of its mission in treating the larger questions of public administration.

I should like to try to help the development of this new science by a few words prompted by two items of news in your issue of July 28, 1910. These items may indicate both the existence and the nature of a Law, perhaps the First Law, of the new applied science—a science which would seek to apply the engineering principles of rational, disinterested constructiveness to the great economic and administrative problems of society.

The first of these items is the one reporting the great efficiency with which the City of Los Angeles is building her 280-mile aqueduct. The other is your Editorial Correspondence calling attention to the really fine possibilities in street-railway service as exemplified by the publicly owned and operated lines of German cities.

Study of these cases in the light of the respective local conditions will reveal to any one, it seems to me, that the vital principle underlying both is simply that *in each case the public interest is practically the sole concern of the city authorities*, and, what is more suggestive still, that this is due in each case to the fact that *the people are actually in control of the city government*.

To be sure this control in Germany is relatively indirect, through the pressure of an enlightened public sentiment. But it works—in Germany.

What works in Los Angeles is something similar, heavily reinforced, however, by means of orderly and direct popular interference on occasions. Los Angeles was one of the first American cities to comprehend that something more vigorous than our traditional methods of indirect control are required to offset the activities of the American boss. Some years ago she accordingly embodied in her charter the Initiative, the Referendum, and the Recall. Thus she equipped herself for orderly interference in her own behalf by direct popular vote, whenever her interests were neglected or threatened. She operated those devices a few times—to the unvarying discomfiture of the bosses and those back of them, and to the proportionate toning up of the public self-respect. The result is sustained majority control. There has followed, just as in Germany, creditable city government, and possibilities for the public welfare otherwise out of the question.

Further instance of the operation of this principle is to be found in the uniformly good results reported from our commission-governed cities. All the characteristic devices of these cities, from the initiative, referendum, and recall to systematic publicity and the small council, operate directly toward popular supremacy in fact. They discourage assaults upon the public welfare, and encourage loyal public service. Thus they tend constantly to keep the public interest not only supreme but unassailed.

Any one wishing to study what is probably the most perfect piece of machinery to this end should turn to the charter under which Grand Junction, Col., is now living. One of its distinctive features, preferential voting—a workable scheme for dispensing with primaries and securing elections in the interest of the majority—has with little modification been embodied in the proposed new charter for Buffalo, already approved by popular vote in that city.

The Denver elections of last May show still further the value of means of popular control suited to the magnitude of the task. Denver, in that election, had the chance by direct popular vote to settle each of a series of twenty-one questions. The voters had the incentive of knowing that as they voted so it would be. Measures were for once disentangled from candidates, from parties, and from one another. Here was a chance for intelligent action. It was fully improved. Despite the lavish use of money and all else that great wealth and the united political machines could do to mislead—and they did much—the people adopted each of the six measures designed for their welfare, and rejected all of the fifteen which were not so designed.

Much more to the same purport might be cited from American experience and on a state-wide scale, as in Oregon, not to mention the even better established Swiss results of direct popular control. But with all this and the general experience of western Europe in view, mindful also of the obvious fact that the majority have nothing to gain from the neglect or betrayal of their own interest, one might in closing venture an expression of the First Law of the Applied Science of Government as follows:

The people must rule—by indirect control so long as that suffices, and, that failing, by regular and orderly direct control to such extent and to such degree of detail as may be required for complete success.

Lewis J. Johnson, M. Am. Soc. C. E.
Harvard University, Cambridge, Mass., Aug. 4, 1910.

Geared Locomotives for a Mountain Line.

Sir: Can you, or some of your readers, refer me to reliable information relative to the performance and economy of geared locomotives, as compared to that of simple rod engines, for use on very steep grades and sharp curves?

We have 25 miles of standard-gage, heavy-traffic coal road, with short maximum grades of 5%, and some curves as sharp as 18°. As these conditions are firmly fixed by the topography of the country, it becomes necessary to adjust the motive power to this gradient and curvature, instead of the usual adjustment of the location to motive power. If a good knowledge of the principles of locomotive power is essential to proper railroad location, it is even more essential when it becomes necessary to design or specify engines most suitable to given extreme conditions of location. In this knowledge the average locating engineer is sadly lacking, and he must call upon the mechanical engineer for help; and the two must work in harmony for best results.

The proper foundation basis on which to compare the economy of any two different types of locomotives is the ton-mile cost of transportation chargeable to the locomotive. And the ton-mile cost involves the first cost of the engine, the maintenance cost, and the operating cost. Furthermore, the period of usefulness of such widely differing types of engines is so variable that the first cost of the engine should properly be considered in the average annual cost, or the actual total cost through the period of life of the engine.

Any data bearing on this subject to which you can sight me will be very greatly appreciated.

Yours truly,

July 28, 1910. "Locating Engineer."

What is the Value of a Degree of Curvature on Modern Railways?

Sir: It would be a matter of interest and help to locating engineers to know the value of a degree of central angle. There seems to be a great diversity of opinion on the subject of curvature. The newer types of freight and passenger engines in use on the western transcontinental roads necessitate a revision of existing figures. An 8° curve is about maximum for mountain roads.

The effort to balance quantities, while it may make good station work, results in a lot of poor location and excessive curvature. Temporary trestles with train haul will result in much better alinement, at no greater cost in the majority of cases, than under the old system of following the side hills exclusively to balance quantities.

The values given of a degree of curvature are generally too small. The loss of time as enginemen will slow up for sharp curves is underestimated. Any information (or directions where to obtain the same) given by your paper or your readers will be appreciated.

F. W. Harris.

Missoula, Mont., Aug. 7, 1910.

Notes and Queries.

Determining the speed of a train.—Counting the clicks of wheels passing over rail-joints for a measured length of time enables the speed of the train to be computed. The following figures are convenient to remember: For 30-ft. rails, count the number of joints passed during 20.5 sec., which will represent the speed in miles per hour. For 33-ft. rails, count the joints in 22.5 sec. to get the speed. (A. Van Rensselaer, Spokane, Wash.)

Modern Highway Bridge Construction.*

By F. T. KERSTING.†

Financial conditions and the rapid growth of the country have made it necessary to do some things in the line of bridge building which were regrettable because the prime object was to build cheap and sometimes quickly-built structures. That state of affairs is improving, and the class of bridges we are to build in this state in the future should keep pace with the improved conditions. Hitherto county courts have been flooded with petitions for bridges, all of which were extremely necessary, and as the funds on hand were limited they were spent to please the largest number of petitioners; hence many flimsy structures were built. Now that those bridges most badly needed are constructed, we should give more attention to the permanence and in some cases even to the ornamental aspect of the structures now to be built.

There are conditions when it is the best policy to build a masonry arch, a steel deck span, a concrete arch, a steel arch, or a steel through span. There is no doubt but that when the funds are on hand and the conditions at the site are favorable it is best to build a concrete arch.‡ It will also be found economical in the long run to build concrete floors on all steel bridges regardless of the length of span.

A general impression prevails that any structure built of concrete is a permanent structure. This is far from

*Abstract of a paper read at the annual meeting of the Highway Engineers' Association of Missouri, at Kansas City, Mo.

†Deputy State Highway Engineer, Jefferson City, Mo.

‡Concrete girder bridges are preferred to arch bridges as a general proposition by Mr. A. N. Johnson, State Highway Engineer of Illinois, one reason being that as the headway is usually low the girder gives less obstruction to the waterway. This was explained in a paper by Mr. Johnson in our issue of Feb. 10, which paper also discussed the questions of cost and workmanship which are treated by Mr. Kersting in the present paper.—Ed.

being the truth, as there is no material of construction in which the personal factor enters so largely. County officials will do well to be careful in awarding contracts on concrete work and look into the qualifications and previous record of the bidder. A plan and specifications should always be followed. A good deal of money is wasted by building concrete structures too heavy while on the other hand many invest concrete with virtues it does not possess, and take great chances. A few counties in this state refuse to build concrete culverts because the first ones built were failures. It seems that you cannot convince the officials that it was not the fault of the material but the fault of the man who built the culverts.

Our mixtures have been uniformly too poor. There is one county where a mix of one part of cement to 13 of mine chaits has been used, the county engineer priding himself on the fact that these arches are standing (they have not been built a year). There seems to be a competition among our county engineers in regard to building cheap structures out of concrete, as for example a 10-ft. arch 18 ft. long, with head walls 8 × 10 ft., for $30. I was asked to spread this good news among brother engineers. This cannot be good work as the cement alone should have cost more than $30. In constructing concrete work the boast should be on good work, not on how cheap it is possible to build a structure.

Every high water period in the state causes an immense loss to counties in bridges being swept away. There is no need for this. If the bridges are located properly, proper precautions taken in designing and placing the foundations, and the waterway not greatly restricted, this loss would be entirely eliminated. Many county officials through an erroneous idea that they are saving the county money, build spans much too short for the waterway required. This is a serious mistake and the cause of the destruction of nearly all of those smaller bridges which have been destroyed by high water. County engineers should see that bridges are placed at a sufficient height above high water so that they will not catch drift.

Particular attention should also be given to the placing of anchor bolts. I have seen several expensive bridges washed off abutments during a time of high water when anchor bolts (which had been omitted) would have saved them. Lately, in this state, a span of 240 ft., which had just been erected, was washed off its piers before the court had accepted the bridge. In this case the contractor stood the loss, which was occasioned most probably by carelessness of the foreman.

To erect bridges cheaply and quickly is the aim of nearly all foremen. In their efforts to do this they sometimes slight the work and this is chiefly done where it cannot readily be seen, as for instance in the placing of anchor bolts which are often the prime factor in the life of a bridge. This has especially been the case in these last few years, when each succeeding spring has brought us a new high water mark on a number of the creeks and rivers in our state.

The state highway engineer is frequently asked about tubular piers, and the inquirer is generally prejudiced against them. The proper material out of which to build piers or abutments is stone and concrete. Tubular piers are, however, an excellent substitute. They have been used for years not only on highway work but also by railways. There are several reasons for this. In the first place there is usually a vast difference in the cost and were it not for the tubular pier many bridges in Missouri could not have been built. Concrete or masonry piers require more excavation and when water level is reached an expensive cofferdam is required along with much more pumping than is necessary in sinking a tubular pier which itself always acts as a cofferdam. When there is no rock foundation the difference in cost is even greater.

There have been more failures of concrete and masonry piers than there have been of tubular piers. In most cases this is due to the poor construction of the masonry. The contractor, in his efforts to be a low bidder, bids a lower price than that for which good masonry can be built. He is not required to work to any specifications and builds the class of masonry it is usual to build in the locality. Therefore there are many masonry piers built of the same class of stuff and in the same manner the mason employs when building a cellar wall.

It is seldom best to award the contract to the lowest bidder for masonry work. Choose some man who you know does good work; adopt a bridge masonry specification and see that it is followed. Some cases of concrete failures are known where the strictest precautions during construction had been taken, and where plain concrete was paid for at the cost of $13.50 per cu. yd., but these were caused by bad judgment, placing piers in the middle of streams when the bridges should have had one span instead of two spans.

The pressure against a tubular pier at time of high water is not great owing to its cylindrical form; it is also not apt to hold drift for this reason. It is bad practice to set a tubular pier on a rock foundation in a stream where it has only a foot or two of gravel or clay to penetrate. In this case it is best policy to build a concrete or masonry pier even though the first cost be twice that of a tubular pier.

It is generally supposed that steel rusts rapidly under ground, the reason for this supposition being that ground holds water longer than does the atmosphere. Water alone will not cause iron to rust. It is the joint influence of water, oxygen and carbonic anhydride which causes rusting. There is a bridge in Perry County, built in 1876, resting on piers made of two Phoenix columns about 10 ins. diameter. After digging a foot or so under the ground surface we found that the paint was still on the columns, though they had rusted somewhat above the ground.

RAILWAY SAFETY APPLIANCE STANDARDS will be the subject of a hearing by the Interstate Commerce Commission at Washington, D. C., 10 a. m., Sept. 29, 1910. The new Safety Appliance Act, passed April 14, 1910, makes new requirements as to hand brakes, sill steps, ladders, running boards and hand holds, and directs the Commission to fix the number, dimensions, location and manner of application of these appliances within six months (by Oct. 14). In accordance herewith the Commission has formulated a code of standards prescribing the number, location, dimensions, etc., of these safety appliances, and has set a hearing, as noted, for the purpose of obtaining opinions and criticisms of this code. The proposed code may be obtained from Mr. E. A. Moseley, Secretary of the Commission.

Methods for the Computation of Reinforced-Concrete Flat Slabs.*

By LOUIS F. BRAYTON.†

Without question, one of the most useful as well as one of the least understood types of construction in reinforced-concrete flat slab. The fact that Mr. Millan's summary indicates a variation of about between the lowest and highest amounts of steel under the various methods of computation when same problem is under consideration fully indicates there is at least no accepted method of computation general use. Without going into the details of various methods it may be generally stated that all of them use as a basis the idea that a slab d in the form of a warped surface. It might be said it is assumed that the slab droops around each in an umbrella form, the curve being reversed approaches the center of the span until it meets corresponding curve from the next column.

In the writer's mind, where the flat slab is designed on columns equi-distanced apart in each direction, that is, the panels being square, and where the load is absolutely uniform all over the entire floor, there is probably no question about the slab deflecting into the form of a warped surface, as described above. However, when a panel is oblong, and the thickness of the slab uniform, there will *probably* be a greater stiffness in the direction of the shorter span and the deflection will not necessarily take the form of a warped surface. The greater deflection in the slab *may* take place along a line perpendicular to the center of the long span. This argument is presented to put the problem in another light. It is not the idea to say that it is impossible for the oblong flat slab to assume the warped surface, but it is intended to say that it may be possible that it may not under all conditions take the form of the warped surface.

Another point of view which must be considered, is that if we grant that the flat slab under a uniform load will assume the form of a warped surface when it deflects, are we at liberty to take this fully into account in making our calculations? Take, for example, a slab supported upon four sides by girders. In this case there can be absolutely no question but what the slab under a load does assume a warped surface, for the deflection under both spans is the same, and, since the girders are considered practically non-deflecting and the center of the slab does deflect, there can be no other condition but that the slab is warped and dished under the load. Building departments and engineers throughout the country do not give slabs supported upon four sides very much credit for this warping. Probably, the most usual concession given by a building department, is that the load may be considered carried in the direction of the two spans; that is, where the panel is square, one-half of the load is carried each way, and after determining the amount of steel required under these conditions, the amount actually required may be considered as equal to three-quarters of that figured, the bars being gradually increased in spacing toward the ends of the span. This, the reader must remember, is a concession made under the condition only where there is absolutely no question that the only form that the slab can assume under deflection is that of a warped surface. In a flat slab where there are no beams along the center lines of the columns, as noted above, it is not certain by any means that the slab under a load will deflect in the form of a warped

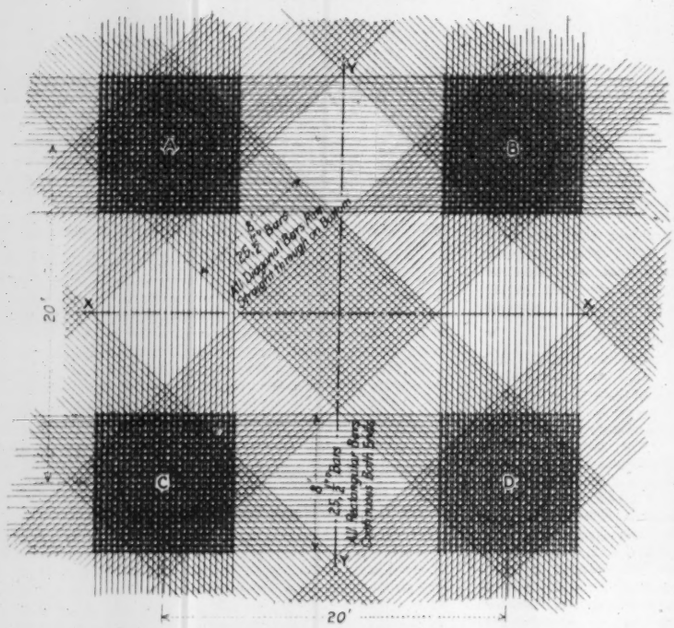

FIG. 1. PLAN OF FLAT REINFORCED-CONCRETE FLOOR SLAB AS DESIGNED BY MR. L. F. BRAYTON.

FIG. 2. MOMENT DIAGRAM OF SECTION THROUGH A-B OF FIG. 1.

FIG. 3. ELEVATION THROUGH A-B (FIG. 1), SHOWING LATERAL BUT NOT DIAGONAL REINFORCEMENT.

*A discussion presented to the National Association of Cement Users on a paper entitled "A Comparison of Methods of Computing the Strength of Flat Reinforced-Concrete Plates," by Mr. A. B. MacMillan, read before that Association at the Annual Meeting, Jan., 1910, and published in Engineering News, March 31, 1910, p. 364.

†Superintendent, Stone and Webster Corporation, 724 Electric Bldg., Portland, Ore.

rface, and under these conditions the attitude of engineers and building departments certainly ought not more liberal than where a slab deflects, as it would en supported by girders on four sides.

Another condition which probably in a large number slabs under test has come into effect, is the fact that e flaring caps in the columns are so perfectly a part the slab and columns at the same time, that a large art of the strength of the slab is due to the fact that is fixed about the columns, and, that through a moent of resistance in the columns the slab is materially rengthened. In other words, an eccentricity is created the column by means of its continuity with the slab. proper engineering design would not contemplate is eccentricity in the columns, unless, the columns ere designed to take it which, in the interest of econmy, can not be done.

It seems to the writer that under the conditions discussed a fair solution of the problem would consider the entire dead plus live load as being carried in the direction of the long span where the length is greater than one and one-half times the breadth, the bending moment, however, being calculated on the most liberal basis consistent with good engineering. When a panel is square, it ought to be fair to go to the extreme limit and consider that the bending moment at the center of the span is equal to $\frac{1}{24}\ WL$, W being the entire dead plus live load. This is equivalent to considering half the load carried in each direction, but using the more conservative factor $\frac{1}{12}$ instead of $\frac{1}{24}$, thus, giving credit for deflection in two directions.

When a panel is oblong to the extent of one and one-half times its width the whole load should certainly be carried on the long span, using a formula for bending moment, giving M equal to not less than $\frac{1}{12}\ WL$ at the center and $\frac{1}{24}\ WL$ at the support.

For panels only slightly oblong it is a question whether the proportion of load carried by the long span can be properly considered as equal to the proportion usually considered in slabs supported on four sides.

The illustrations given herewith represent a flat slab where the columns are spaced 20 ft. on centers each way and where the design is made for a live load of 200 lbs. per sq. ft. A plan (Fig. 1) is given showing the arrangement of the bars, their number in each band and the widths of the bands. A moment diagram (Fig. 2) is given taken along the center line of columns A-B. A section (Fig. 3) is shown also of the slab taken along the same line indicating the arrangement of the reinforcement constituting the band A-B, but not indicating the bars in the diagonal bands. In the moment diagram a parabolic moment diagram indicates the location of the moment when it is considered that one-half of the load is carried in the direction of each span, the bending moment M being considered as equal to $\frac{1}{12}\ \frac{WL}{2}$ at the center of the span and $\frac{1}{24}\ \frac{WL}{2}$ at the point of support. This negative moment of $\frac{1}{24}\ \frac{WL}{2}$ at the support, however, is based on a strip of the same width as that considered at the center of the space and since the width of the column cap resisting negative moment is only about 40% the width of the panel, the total negative resistance which must be provided per foot of width of cap must be at least two and one-half times this amount.

In order to design a slab and reinforcement to resist these bending moments, a strip 1 ft. in width running from A to B is assumed having a span of 20 ft., and a live plus dead load of 307 lbs. per sq. ft. Using a stress in the steel of 16,000 lbs. per sq. in. and an extreme fiber stress in the concrete of 600 lbs. per sq. in., it will be found that a net depth of 7½ ins. at the center of span is necessary, that the steel required at the center of the span must be doubled over the column, and that since the entire strength of the concrete at 600 lbs. per sq. in. has been developed at the center of the span the compression resistance must be increased enough to take care of the negative moment of resistance at the point of support. The cross-section through the slab along the line A-B indicates how this steel is bent to the exact form and how the overlapping ends coming from each side of the column give over the column double the amount of steel that is supplied in the center of the span. The moment diagram shows on the right the positive moment of resistance at the center of the span and negative moment of resistance toward the point of support as it is created by the doubling of the reinforcement at the top of the slab, and the increasing of the compressive resistance of the slab due to the influence of the flaring column cap, and the diagonal reinforcement of the slab. It will be seen by the resistance diagram on the right that the shaded area amply covers the moment diagram.

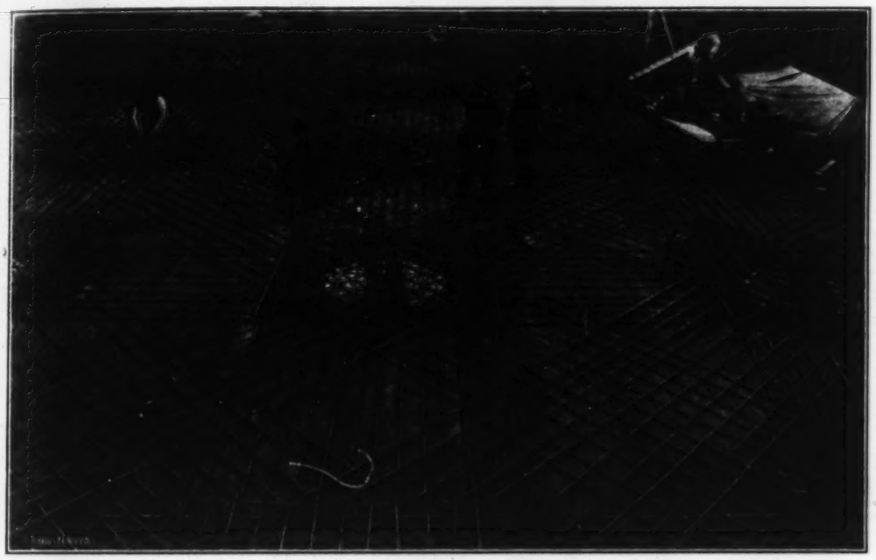

FIG. 4. VIEW OF FLOOR SLAB UNDER CONSTRUCTION SHOWING METHOD OF ARRANGING REINFORCEMENT.

Having determined the amount of steel required per foot of width in the band A-B, the next step is to determine the width of this band. As it is considered that the slab might fail by deflecting along the line Y-Y it will be seen that concrete will be put into compression and steel will be put into tension along lines perpendicular to Y-Y, no matter whether the point considered is within the band A-B or in one of the bands, A-D or C-B. The fact that the steel through the center of the panel is placed diagonally does not necessarily mean that the lines of stress in the concrete must be diagonal, for, since the line Y-Y may be along the line of maximum deflection, the lines of stress will be perpendicular to Y-Y. So far as concrete compression stresses are concerned this is simple, and so far as the steel is concerned it is simply necessary to resolve the tensile stress in each bar into its components, parallel and at right angles to Y-Y. The sum of the components of the two bands A-D and C-B perpendicular to Y-Y must be the tensile resistance required for that portion of the panel not covered by bands A-B and C-D. In a square panel it will be seen that 0.707 of the stress in any bar running diagonally will be equal to its component perpendicular to the line Y-Y. Since we have two diagonal systems crossing this portion of the panel the total stress perpendicular to the line Y-Y will be equal to 1.414 times the tensile strength of either system, consequently, if we adjust the bands A-B and C-D to such a width that the strip between which remains must be equal to 1.414 times the width of the band A-B and place the same amount of steel in all four bands we have supplied the proper amount of steel to resist bending also the line Y-Y.

In the system here illustrated it is customary to have the bars in the rectangular bands bent and continuous at both ends, while the diagonal bars are straight and run through on the bottom. The rectangular continuous bars are erected first, the diagonal bars being afterward threaded under the negative bars over the column. A study of this system will show that every bar is either carried directly or indirectly over the column cap.

Attention is called to the Fig. 4, showing the reinforcement used in which the shear is largely taken care of in the steel.

With the arrangement given it will be found that the double continuous rectangular reinforcement in a square panel will almost exactly equal in length the diagonal distance between column centers, consequently whether the diagonal steel be carried through the column continuously, or, whether it be spliced with broken joints the amount of steel required for the entire panel will be equal to four times that required for one band having a length equal to the diagonal distance between centers of columns.

Following is the solution of the problem already stated considering the half load carried in each direction and the bending moment at the center of the span equal to $\frac{1}{12}\ \frac{WL}{2}$.

Panel = 20 × 20 ft.
Live load = 200 lbs. per sq. ft.
Dead load = 107 lbs. per sq. ft.
Stress in steel = 16,000 lbs. per sq. in.
Stress in concrete = 600 lbs. per sq. in.

M at center $= \frac{1}{12}\ \frac{WL^2}{2} = 5{,}110$ ft-lbs.

This gives a net slab depth = 7½ ins.
a total slab depth = 8½ ins.
metal per foot width = 0.6 sq. in.
Then metal for 8½ ft. width = 5 sq. ins.
= 25 ½-in. rounds.
Spacing in 8½ ft. = 4 ins. c. to c.
Total steel in panel = 1,900 lbs.
Weight of steel per sq. ft. of surface = 4.75 lbs.

It may be noted that when a square slab is designed on a basis as set forth above, L being the distance from center to center of column and W being the total dead plus live load per square foot, the weight of steel required in the slab per square foot may be closely determined by the following romula:

$0.135\ L\sqrt{W}$ = the weight of steel per sq. ft.

Applying this to the above problem we have:

$0.135 \times 20 \times \sqrt{307} = 4.73$ lbs. per. sq. ft.

It is interesting to compare the above design with various designs given by McMillan. For purposes of comparison McMillan's table with the above result added are herein reproduced.

FIBER STRESS.

Method.	Thickness of slab.	Per sq. in. in steel.	Lbs. steel in panel.
1. Cantilever	8 in.	16,000	2,189
2. Turneaure and Maurer	12 in.	16,000	1,931
3. Grashof	8 in.	16,000	784
4. Mensch	8 in.	16,000	2,129
5. Turner (a)	8 in.	16,000	549
(b)	8 in.	13,000	718
6. McMillan	8 in.	16,000	1,084
7. Brayton	8½ in.	16,000	1,900

The writer believes that the system shown, particularly in its detail, has advantages which are apparent to most engineers in that the shear or diagonal tension in the slab is very materially assisted by the arrangement of the reinforcement, and the bars because of being bent mechanically are positively located so that they take care of the negative bending moment.

The bending of these bars economically done by means of a right and left double bar bender at a very low cost, puts four bends in a bar at once and ensures the bending of the bar to exact detail. Springing the bars into place, or allowing them to sag under their own weight, leaves a great deal to the contractor and causes a lack of confidence in the engineer that the reinforcement will be placed exactly as he intended it. Circular cracks running around the top of a column in a slab are utterly impossible when the steel is as exactly placed as it is shown in these photographs. The fact also that only two systems of steel occur in the top surface means that the effectual depth is not materially decreased as it is where it is necessary to carry all four systems to the top surface.

The Valuation of the Detroit Street Railways.

For some time past there have been in Detroit (as in several other large cities) controversies between the municipal authorities and the street railway company over matters of franchise rights. In view of the approaching expiration of the franchise rights of certain lines, the mayor, Mr. Breitmeyer, appointed a committee of 50 citizens to investigate and report upon the situation. The investigation was to form the basis of negotiations for a settlement with the company. One of the important duties of this committee was to have a valuation made of all the street railway property (tangible and intangible), and this work was assigned to a subcommittee of seven members. Mr. Frank W. Eddy is chairman of the main committee, and Mr. Joseph Boyer is chairman of the subcommitee on appraisal. This latter body appointed Mr. Frederick T. Barcroft, M. Am. Soc. C. E., consulting engineer, of Detroit, to make the valuation of the physical property of the company.

As this valuation was on behalf of the city, the company decided to have an independent valuation made on its own behalf and employed for this purpose Mr. R. B. Rifenberick. The comparative figures of the two valuations are given in Table I. It will be seen that the valuation made for the company was very much higher than that made for the city ($24,676,182 as against $11,121,725). We are informed, however, that in 1900 the company had an appraisal made, with a total valuation of $7,806,737, but it is probable that this is not directly comparable with the present valuation.

In the present appraisal by the company, the amounts for most of the items are approximately double those of the city's appraisal, while the valuation of the track is nearly four times and that of the shops about three times as great as that of the latter. The company's valuation does not include the item of overhead charges, which item is included in the other valuation. On the other hand, the company's valuation included about $1,200,000 for paving, while the city's valuation omits paving entirely, as not being an asset of the company. The opinion of the city's appraiser on this point is quoted in full later. Neither appraisal includes an estimate on franchise values, but Prof. Henry G. Adams (on behalf of the city) has estimated the value of unexpired franchises at $2,810,600.

While the total value as estimated by the city's appraiser was less than half the value estimated by the company's appraiser, the subcommittee on appraisal has recommended that this former total ($11,121,725) should be reduced to the extent of nearly $3,000,000 in the event of the city's failure to make a satisfactory settlement with the company, and the consequent termination of the present relations as to traction matters. This reduction applies to the physical property only, but the sub-committee considers that the franchise value also should be reduced by $998,000 (or to $1,812,600) under the conditions of failure to arrive at a settlement with the company. The substance of the sub-committee's statement on this subject is as follows:

> This appraisal [on behalf of the city] was made of the value of the Detroit United Ry. as a going concern in its present condition, under the supposition that present traction relations are to continue. Should no settlement be arrived at satisfactory to the city of Detroit, then this approval should be reduced in the following items and amounts:
>
> (A) Real estate in such amount as the land now occupied by its power plant shall bear to the whole amount.
>
> (B) Power plants, $1,219,051. In connection with this item your committee begs to state that power can now be and is purchased much cheaper from central power plants than it can possibly be produced by the railway company, which is compelled to equip for the maximum load, with the result that during the greater portion of the 24 hours a part of the equipment is idle. Conditions are rapidly reaching a period when water-power companies will deliver power in this city at a minimum of the present cost to produce from coal.
>
> Again, the city has the electric lighting plant which could divert in power during certain portions of the day to the traction department at a very much reduced cost. We therefore unhesitatingly declare that this item should be eliminated. In proof of this statement, the railway now finds it advantageous to purchase from the Edison Illuminating Co. approximately 3,500 HP. units daily.
>
> (C) Materials, supplies, furniture, etc. This item, $728,158, should be reduced approximately $600,000. This item covers stock, supplies, materials and tools employed and used in the repair of the interurban cars, and which our engineers were unable to separate from that used in the manufacture and repair of city cars and equipment.
>
> (D) Overhead charges, or cost of organization, $1,024,310. This should be eliminated in the event that no settlement is reached, inasmuch as this item naturally disappears with the expiration of franchises.
>
> (E) Franchises. The value placed upon the unexpired franchises was computed by Prof. Adams under the operating relations as they now exist; that is, as to rates of fare, etc. Under this valuation it is obvious that certain portions of through routes are given a value which might disappear entirely if transportation on those outlying portions were estimated independently of their operating relations with operations upon streets on which the franchises have expired. Eliminating these portions would reduce the value of the franchises approximately $998,000. It is apparent also that this value would be further reduced by the credits, due the city, upon the lines where franchises have already expired.

TABLE I.—VALUATIONS OF THE PHYSICAL PROPERTY OF THE DETROIT UNITED RY. CO.; DETROIT, MICH.

	Valuation for		
	The city		
	Cost.	Present value.	The company.
Real estate	.....	$513,548*	$999,249
Buildings, except power-houses and battery stations	$718,968	578,763†	902,291
Power plants, including buildings	1,481,328	1,219,051	2,651,137
Battery stations, including buildings	.....	200,488	429,068
Power distribution, including overhead feed wires and telephone system	1,211,897	1,088,062	2,010,740
Track	3,601,335	2,599,222	9,349,407
Rolling stock, including equipments	3,676,098	2,861,403	5,129,954
Shops	390,968	308,719	984,117
Tools, materials, supplies, furniture, etc.	.....	728,158	981,029
Overhead charges	.....	1,024,310	.....
Paving	.....	.....	1,219,817
Other items	.....	.....	25,327
Total	.....	$11,121,725	$24,676,182

*This is for the 50.02 acres in use for railway purposes; the total for all real estate (68.39 acres) owned is $685,320.

†Exclusive of $24,045 for buildings not used for railway purposes.

With this review of the general situation we may turn to the report of Mr. Barcroft's appraisal, which forms a cloth-bound volume of 237 pages (9 × 11½ ins.); it has numerous illustrations, and also eight maps showing various kinds of information in regard to the traction system. A tabular statement as to the expiration of franchises shows that on 71.6 miles the franchises expired between April, 1906, and July 24, 1910; on the remaining 98.8 miles they expire at various dates between Oct. 17, 1915, and May 3, 1935.

In a summary of the history of the traction system, the report shows that the Detroit United Ry. Co. is the successor and sole survivor of some 50 corporations that have been organized or engaged in the transportation business in Detroit (and in suburbs subsequently annexed to the city) since the first franchise was granted to the incorporators of the Detroit City Ry. Co. in 1862. The present company's system within the city limits includes 170.41 miles of track over which are operated 998 revenue cars, in addition to interurban traffic. The motive power is supplied from two power stations, having a generating capacity of 13,500 KW., in addition to which the company purchases 3,100 KW. from the Edison Co. The equipment also includes 14 air compressors and five air-charging stations (for the brake system), two shops for repairs, and two battery stations.

From the report it appears that the company's records of its property, its work, and its purchases and expenditures are very incomplete and unsystematic. This is shown particularly in regard to the track and rolling stock.

REAL ESTATE.—This part of the property was inspected and valued by a committee of five members of the Detroit Real Estate Board. Details of the valuation are given in Table I.

BUILDINGS.—The company has 56 buildings in use and 23 buildings (old horse barns, car barns, etc.) which have no connection with its operations and are practically useless. The report states that (with a single exception) uniform ugliness is the characteristic of the buildings, although many of them are located on prominent streets and avenues. The major part of them are of common brick. It is suggested that an ordinance should be passed requiring plans for all buildings to be approved by the City Plan and Improvement Commission.

POWER PLANTS.—The company has two power-houses, but purchases a considerable amount of power from a central station plant. It is pointed out that future development indicates the ultimate shutting down of the power plants and the renting of electrical energy because of the cheaper cost and the elimination of power-house investment and fixed charges. The present power plant has been appraised on the basis of what it is doing, and not as a mere assortment of machinery and material. The station buildings are included, as they serve simply to shelter the plant.

Station A has 12 water-tube boilers of 250 HP and four of 354 HP., 4 tandem-compound engines of 1,500 HP., 1 cross-compound of 2,500 HP., 4 generators of 1,000 KW. and 1 of 1,500 KW. Station B has 24 water-tube boilers of 250 HP. to 350 HP., 2 engines of 2,250 HP. with 1,500-KW. generators, and 2 each of 1,200 HP. and 600 HP. with generators of 800 and 400 KW.; it has also a Parsons steam turbine of 4,500 HP. with a 3,000-KW. generator. The total value of these stations is estimated as follows:

	Cost.	Present value.
Station A	$626,248	$502,681
Station B	855,080	716,370
Total	$1,481,328	$1,219,051

The two battery stations have storage batteries of 2,500 and 2,000 ampere-hours capacity respectively.

POWER DISTRIBUTION.—This includes the poles, overhead and underground equipment, etc. A careful inspection was made of all materials, a tower wagon being used in inspecting the pole fittings and overhead work and in calibrating the trolley wires. The feed-wire system was plotted on maps, and inspections were made in different locations to arrive at the conditions. In regard to this part of the appraisal the report states as follows:

> The company has no record of the number of poles and their locations renewed during the past ten years. The equipment comprises both wood and iron poles. Every line in the city was inspected and from 10 to 15 poles per mile were uncovered at the ground line to enable the inspectors to reach a conclusion as to the average condition. This was done on both types of poles, for while it is a well known fact that depreciation on wood poles follows a known mortality, that on iron poles is wholly subjected to a maintenance condition. Properly maintained there should be no reason for replacement of iron poles for an indefinite term of years. Examinations of wood poles were made to confirm (or to see wherein they varied from) the mortality tables compiled by the government from the many railway companies, the experience of large dealers in this material, and lastly and principally by that of considerable personal experience.
>
> Recent developments in reclaiming iron poles have fairly fixed the depreciation, so that the only element applied against them has been such as condition disclosed. As a general rule they are well set and in good condition, sound and not badly pitted. The exceptions were marked and were wholly due to insufficient maintenance. The life of the majority of them could be materially increased by proper painting, which should be done only under the most severe inspection. The wood poles examined bore out the average conditions, as known from personal experience.
>
> The great network of wires leaves the power-house and run for nearly a mile up Riopelle St. before reaching the lines which the wires feed. The distribution and oversight of all wires in the city should be under the arbitrary control of the city electrician. While these wires transmit all the energy necessary to propel all the cars in the city, their present location is most unsafe and improper. Should any catastrophe occur in this part of the city, such as fire or tornado, the wrecking of these feed wires would not only mean considerable loss of money, but most serious inconvenience and hardship to the public by the possible stopping of transportation for an unknown period. Such contingencies have occurred in other cities, and it should be someone's business to

...that present conditions are altered without delay and ...ided in the future.

Some of the prices used in this valuation were as ...lows:

...dar poles, 30, 35, 40 & 45 ft.	$5.50, $7.25, $10.25, $12.50
Erecting	$4
...daho poles (cedar), 50, 55 and 60 ft.	$14.25, $16, $21
Erecting	$5.35
...ine poles (octagon), 30, 35 & 40 ft.	$7.50, $10.25, $12.50
Erecting	$4
...on poles (per 100 lbs.)	$2.75
Erecting	$9.78
...oss arms, iron	$2.20 to $3.50
Maple, 2, 4 and 6 pins	30, 35, 60 cts.
...able, per lb.	17 cts.
...pan wire, 5/16-in. double-galv., per 100 ft.	$1
Erecting, per span	$1
...rolley wire, 2/0 copper, hard-drawn, per lb.	18 cts.

TRACK.—The difficulties of valuation of this part of the property may be judged from the fact that it has 21 types of rails, 95 types of track construction, and 204 types of construction, including paving. It appears that the company has no records of its track construction or replacement work. In a later issue we shall give some further particulars in regard to the valuation of the track, but a general summary is given in Table II.:

TABLE II.—VALUATION OF TRACK; DETROIT UNITED RY.

	Cost.	Present value.
Straight track	$2,534,565	$1,821,922
Stations and yards	116,686	81,780
Special track work	708,804	473,169
Interlocking	31,442	23,120
Catch basins, manholes, hydrants	39,796	39,796
Shop yards, machinery, tools, div. foremen's outfit, etc.	169,952	159,435
Total	$3,601,335	$2,599,221

ROLLING STOCK.—In making this appraisal the cars were considered as part of the equipment of a going concern, and were not valued at their forced sale or scrap value, except when the material was fit for scrap only. The revenue equipment includes 748 single-truck or four-wheel cars and 253 double-truck cars. The non-revenue equipment includes three special cars and 106 miscellaneous work cars (snow plows, sprinkling cars, derrick cars, pile driver, concrete mixer car, rail grinding car, flat cars, etc.). It is stated that the company has no records showing the number of cars, trucks, motors and equipment purchased each year since 1900. For valuation, the cars were divided into groups, each representing those purchased or built under the same contract and specifications. One or two cars of each group were examined in detail and checked carefully with the specifications; every car was examined as to its general condition. The valuation may be distributed as follows:

Revenue cars (1,001); bodies and trucks	$1,788,124
Equipments (motors, brakes, elec. fittings, etc.)	998,746
Non-revenue cars (100); bodies and trucks	100,669
Equipment	74,533
Extra trucks and other fittings	14,125
Total value	$2,861,493
Total cost	$3,676,098

MECHANICAL DEPARTMENT.—There are two repair shops. The Monroe Ave. shop is said to be poorly arranged and ill adapted to its purpose; this results in delay to the work, excessive assembling costs and increased cost of maintenance of the equipment. The Harper Ave. shop is in better condition, and this does a considerable amount of work for the track and bridge departments. The valuation of the shops, and of the air-compressor and charging stations for the air-brake equipment, is as follows:

	Cost.	Present value.
Monroe Ave. shop	$231,475	$174,074
Harper Ave. shop	29,185	24,578
Air-compressor & charging outfits (19)	81,483	71,298
Car-inspectors' stock and outfits	48,825	38,769
Total	$390,968	$308,719

The parts of the report which deal with the subjects of overhead charges and paving we quote below, as these apply to street railway valuations in general. We may note also that while Mr. Barcroft, the appraiser on behalf of the city, omits all consideration of paving as an asset of the company, the company puts a valuation of nearly $1,220,000 on this item in its own appraisal:

OVERHEAD CHARGES.—These are so called from the fact that they encompass every item in the entire capital expenditure for physical items to a greater or lesser degree, and are distributed under such divisions as organization, finance, taxes, investment, interest, legal expenses, litigation, expenses of insurance, guarding against injuries and fire during the construction period, miscellaneous expenses, such as general administration of property, contingencies, and the technical assistance employed in the various engineering branches.

Overhead charges should be only those things for which money has been spent in the necessary work of constructing the property and putting it in operation. The various items making overhead charges fluctuate more or less in different localities from such causes as seasons, labor, surroundings, and many other conditions, as illustrated by Justice Brewer in one of his opinions:

If it be said that the rates must be such as to secure the owners a reasonable percentage on the money invested, it will be remembered that many things have happened to make the investment far in excess of the actual value of the property: injudicious contracts, poor engineering, unusually high cost of material, rascality on the part of those engaged in the construction or management of the property. These, and many other things, as is well known, are factors which have largely entered into the investment with which many railway properties stand charged. Now, if the public was seeking to take title to the railway by condemnation, the present value of the property, and not the cost, is that which it would have to pay.

These charges have been reduced in many cases to a percentage, based on the total cost of construction involved, and as applied to street railway systems have been claimed as from 5 to 28% and even as high as 40 and 45 or 51% by various advocates. But in few cases are they supported by any positive proof, nor are there any history or facts given that peculiarly belong to the history of the company under discussion. Hence the danger of applying the experience of one company to another in an entirely different locality on such an item as overhead charges, where 1% difference may mean hundreds of thousands of dollars.

PAVING.—Paving has not been considered an asset of the company in the preparation of this appraisal. There seemed to be no question concerning this, but the director of appraisal, desiring to dispose of the matter positively submitted the following question: "Is the paving between rails and between tracks to be considered as an asset, or is it a matter of tax?"

The opinion of Mr. P. J. M. Hally, Corporation Counsel, and a majority of the legal committee was to the effect that the legal title to the pavement is in the city of Detroit and not in the company. It is not a part of the property of the company, in the sense of being an asset. The presumption is quite general that the streets belong to the public, and in giving the company the right to lay tracks and operate its cars over such tracks, the public has not relinquished any equity in the streets or paving, and the company is required to keep them in as good a condition as the balance of the street.

This proposition was warmly debated and hotly contested three years ago in Chicago. While the companies there were allowed a nominal sum for paving, the valuations made by the companies were in no case determined by unit price per yard, and were included in the final settlement for a sum for paving in bulk, which was quite insignificant and apparently was allowed solely for the purpose of effecting a compromise of differences, as well as to facilitate final settlement of disputed portions of the appraisal as a whole.* In no case did the public waive ownership of paving or grant valuations for such paving in the appraisal of the railway companies' property at any figure resembling what was the actual value of such paving as paving.

Disturbing and replacing the pavement adds no value to it. Neither can the company claim credits, as it requested, for theoretical items. If there is any value to the pavement to which the company is entitled, it must be upon some different theory than that it is an asset, for so far as the company is concerned it is an obligation foreign to its needs as a transportation proposition and is in "lieu of other taxes." When certain taxes and municipal charges are remitted by the authorities and the company assumes the obligation of paving, there can be no question that the paving thereby becomes a tax.

The paving can have no value to the company when it was all new and laid at one time, and then only in the sense that it has prepaid its taxes up to the point of the first renewal. Thereafter the repairs and renewal become an annual maintenance charge or tax.

If the company has charged the maintenance of this paving to capital account, it is not justified in so doing, and has done so because it has not provided for the renewal of any physical property by a depreciation reserve; and if it has charged this to operation or maintenance under those circumstances, the result is a tax, by whatever name it has labeled it.

The company should have been compelled to charge the cost of original paving to "cost of initial paving" account, which would be automatically wiped out in eight years (assuming, for example, that this is the life of the paving) by being credited with one-eighth of the cost of the paving annually. The maintenance and repairs after the above date should be charged to operating account "paving."

*Engineering News, March 10, 1910.

For the sake of completeness and as having a possible bearing upon the final use which will be made of Mr. Barcroft's valuation we summarize here the results of an inquiry which we have made regarding a controversy over the valuation which arose between the sub-committee and the main committee:

It may be well to refer briefly to the controversy which has occurred over the handling of this city's appraisal, and in which local politics have been concerned. This controversy is distinct from the dispute as to the accuracy of the valuation. The appraisal was adopted unanimously by the sub-committee which had engaged Mr. Barcroft, but unfortunately a difference arose between this committee and the main committee as to the future steps to be taken. The main committee (which had prepared a franchise to be offered the company) proposed to submit this appraisal and the company's statement to a "board of arbitration," although the company had made no agreement to abide by the decision of such a board. Mr. Barcroft (under the advice and approval of the sub-committee on appraisal) declined to have any dealing with this body until its purpose and limitations, and the definite application of the results of its action, had been agreed to by both the city and the company. Some of the members of the main committee undertook (on their own responsibility) to engage another engineer to handle the matter before the board of arbitration, but it was found impossible to proceed without the assistance of the appraisal committee and Mr. Barcroft, and of the latter's numerous assistants (some 30 in number).

It would have been necessary, therefore, for the main committee to disregard its own appraisal committee and have a new appraisal made, but it was not considered advisable to take such a step or to incur such additional expense. Mr. Barcroft's position, as stated to the Mayor, is that the matter should be now in the hands of the corporation counsel for legal advice in protecting the city's interests. The Mayor has since then dismissed the Committee of Fifty. The entire matter has been returned to the city council, the franchise committee of which refused to submit it to the city's legal department. Mr. Barcroft declined to act further until he had proper legal assistance, and in this position the matter rests.

Since then the company has proposed that an engineer should be appointed by the city to make a new appraisal at the expense of the company, but providing that the cost of this as well as of the company's previous valuation should be added to the appraisal. This plan has been strongly opposed, and no action has been taken. In a statement to the committee Mr. Barcroft explained that while the company furnished information that was trivial or that could be obtained without its assistance, no details of original cost of the property or information divulging the company's records or private business methods could be obtained, although it had promised the committee to render him all assistance in this direction. The company, on the other hand, claims that all necessary information was furnished, including schedules of its own valuation.

It is to be noted that while the Committee of Fifty was created and appointed by the Mayor, it was not confirmed or recognized by the council until the appraisal was completed. Then the council, as a body, examined the appraisal carefully at Mr. Barcroft's office, with the result that it purchased it and had it printed.

COAL MINE ACCIDENTS IN THE UNITED STATES in 1909 are reported in a bulletin of the Geological Survey. The total number of persons killed in the year is given as 2,412; injured 7,979. The disaster in the mine of the St. Paul Coal Co., at Cherry, Ill., is not included because the report of the Illinois State mine inspectors was made for the fiscal year ending June 30, while the Cherry fire occurred in November. The number killed in the Cherry accident has been reported as 393. The number of non-fatal accidents, 7,979, is unprecedentedly high, exceeding the figure for 1908 by more than 1,200. The number of fatal accidents, 2,412, is smaller by 38 than that for the preceding year. Comparisons are not quite fair, however, because the reports for 1909 were more complete than those for any preceding year. As usual, the greatest number of fatal accidents was due to falls of roof and coal, which were responsible for over 49% of the total number of fatalities. Explosions of gas and dust caused less than 14.5% of the total number of deaths.

RAILWAY STATISTICS OF THE COMMONWEALTH of Australia are summarized as follows by U. S. Consul Henry D. Baker, of Sydney, in U. S. Consular Reports:

In 1909 there were 1,580 miles of railway in Australia owned by private companies, of which 943 miles were for general traffic, and 637 miles for special purposes. The capital cost of these private railways, with the exception of 283 miles for which statistics were not available, was estimated at $15,091,233. The gross earnings in 1908 amounted to $2,276,608, and the working expenses to $1,320,136; the trains covered 1,389,883 miles, and carried 920,000 passengers and 1,627,000 tons of freight. At the date covered by these figures there were 16,653 miles of government railways open for traffic in the Commonwealth.

The number of employees is given as follows: New South Wales, 5,523; Victoria, 312; Queensland, 614; West Australia, 354; Tasmania, 105; total, 6,908.

During 1909 the 226 miles of tramways (electric railways) in Australia carried 226,775,000 passengers at a working expense of $4,597,812, and with a gross revenue of $6,904,354. The total capital cost of these electric railways was $24,806,809. The mileage of electric railways was divided between the states as follows: New South Wales, 105; Victoria, 34; Queensland, 31; Western Australia, 47; Tasmania, 9.

German Standard Specifications for Delivery and Testing of Portland and Iron-Portland Cement.

The Association of German Portland Cement Manufacturers working together with the Royal Laboratory for Testing Materials at Gross-Lichterfelde, have recently issued a standard specification for Portland cement, which should be accepted as the latest development along this line in Continental Europe. At the same time a similar specification was issued on the so-called "Eisen-Portlandcement," or "Iron Portland Cement," a recent invention in which iron compounds largely supplant the aluminates of the ordinary cement, making the iron-cement much better able to resist the attacks of sea water. Each of these specifications has received official approval by the Prussian Minister of Public Works, who agreed to them in a decree of March 10, 1909.

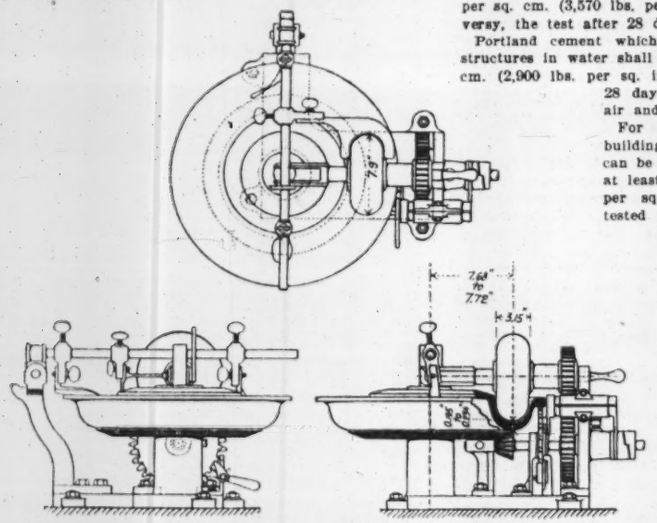

FIG. 1. STEINBRUCK-SCHMELZER MORTAR-MIXING MACHINE FOR TESTING SPECIMENS.

As there has been no little criticism of the specifications for cement generally used in this country, particularly of that part of the specification that relates to testing, we think that the translation of the important feature of the new German specifications, as given below, may be interesting to cement engineers.

STANDARD SPECIFICATION FOR UNIFORM DELIVERY AND TESTING OF PORTLAND CEMENT.

1. DEFINITION.—Portland cement is a hydraulic cementing material with not less than 1.7 parts by weight of lime to 1 part by weight of soluble silica (SiO_2) + alumina (Al_2O_3) + oxide of iron (Fe_2O_3). It is prepared by first grinding and intimately mixing the raw materials, then burning the mixture at least to incipient fusion and finally pulverizing. It shall contain not more than 3% of other materials added subsequent to calcination.

The maximum content of magnesia shall not exceed 5% and that of sulphuric anhydride shall not exceed 2½%.

2. PACKING AND WEIGHT.—Portland cement is generally packed in bags or barrels. The package should show besides the gross weight and the term "Portland Cement" the name or trade mark of the firm clearly printed thereon. Loss by sifting out as well as variations from the standard weight are admissible to the extent of 2%.

3. SETTING.—The initial set of normal Portland cement shall not take place in less than one hour after gaging. For special purposes a quicker setting Portland cement can be prepared; such cement is to be marked on the package accordingly.

4. CONSTANCY OF VOLUME.—Portland cement must be of constant volume. As a decisive test, a pat of neat cement, prepared on a glass plate and protected from drying out, and placed under water after 24 hours, shall show no sign of distortion or cracking on the edge, even after a long time.

5. FINENESS OF GRINDING.—Portland cement shall be ground so fine that it leaves a residue of not more than 5% on a sieve of 900 meshes per sq. cm. (5,800 meshes to the sq. in., i. e., a 76-mesh screen) the width of the mesh being 0.222 mm. (0.0087 ins.) For the test 100 gr. of cement are to be used. Differences in the width of the meshes between 0.215 and 0.240 mm. (0.0085 and 0.0094 ins.) shall be admissible.

6. STRENGTH TESTS.—Portland cement shall be tested for compressive strength in a mixture of Portland cement and sand, according to uniform methods, on cubes having 50 sq. cm. (7.75 sq. ins.) surface.

7. STRENGTH.—Slow setting Portland cement shall show at least 120 kg. per sq. cm. (1,710 lbs. per sq. in.) compressive strength when tested, 1 part by weight of cement to 3 parts by weight of standard sand, after 7 days hardening (1 day in moist air and 6 days under water). After a further hardening of 21 days in the air of a temperature of 15°—20° C. (59°—68° F.) the compressive strength shall amount at least to 250 kg. per sq. cm. (3,570 lbs. per sq. in.). In case of controversy, the test after 28 days is to be accepted.

Portland cement which is intended to be used for structures in water shall show at least 200 kg. per sq. cm. (2,900 lbs. per sq. in.) compressive strength after 28 days hardening (1 day in moist air and 27 days in water).

For immediate inspection at the building site a test on tensile strength can be made. The cement shall show at least 12 kg. per sq. cm. (171 lbs. per sq. in.) tensile strength when tested in a mixture of 1 part by weight of cement to 3 parts by weight of standard sand, after 7 days hardening (1 day in moist air and 6 days in water.)

The strength of quick setting Portland cements is generally less after 28 days than that given above. On this account, besides the strength values the time of setting should also be marked on the package.

Testing Specimens.

As it is important to obtain concordant results when testing the same Portland cement in various places, the rules given hereafter must be carefully adhered to. In order to get correct average figures, at least five sample specimens must be made for each test.

MIXING THE MORTAR.—The mixing of the mortar of 1 part by weight Portland cement and 3 parts by weight of standard sand should be done on the Steinbrück-Schmelzer mortar mixing machine (Fig. 1) in the following manner: 400 grs. of Portland cement and 1,200 gr. standard sand are first mixed dry with a light spoon in a dish for one minute. To the dry mixture is added the quantity of water to be determined beforehand. The moist mass is then mixed another minute and then distributed equally in the mortar-mixer and worked through 20 revolutions.

QUANTITY OF WATER.—The amount of water for the standard mortar is determined by using square molds in the following manner: Dry mortar mixtures of the quantities given above are gaged in the first test with 128 gr. (8%) and, if necessary, in the second test with 160 gr. (10%) of water, and mixed in the mortar-mixer as indicated; 850 to 880 gr. of the ready mixed mortar are put in the mold (Fig. 2), the upper box of which is provided with two notches at the lower part as illustrated, and stamped in the Boehme hammer with 150 (Fig. 3) blows.

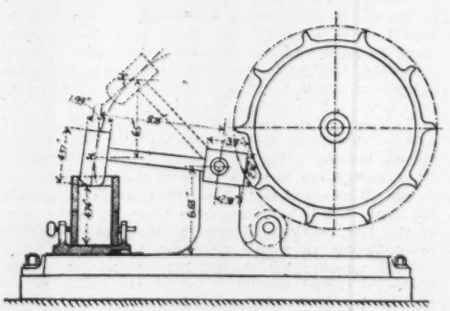

Fig. 3. Boehme Hammer for Use on Concrete Mortar Test Pieces.

The behavior of the mortar when stamped regulates the right quantity of water to be added, as follows: The water addition is correct, if between the 90th and 110th blow water begins to flow out of one of the two notches.

Three specimens shall be tried to determine the correct amount of water to use.

MANUFACTURE OF THE SPECIMENS.—S... of standard mortar shall be made as follow... 880 grs. of mortar, mixed as prescribed, are ... the standard die-molds and stamped by the ... hammer with 150 blows.

The specimens so made are scraped on the ... with a knife, and are then planed and marked ...

The amount of mortar which can be made ... gr. Portland cement and 1,200 gr. standard sand ... for two standard cubes.

The specimens are placed with the mold on ... forated bed in boxes to be kept moist and ... They are taken out of the molds after about ... 24 hrs. after the manufacture the specimens ar... from the boxes and placed under water having ... perature of 15° to 18° C. (59° to 64° F.).

The specimens destined for the hardening under water must be taken out of the water just before the test. The water should not stand more than 2 cm. (0.8 ins.) above the specimens and should be renewed every 14 days.

The specimens destined for hardening in air must be placed standing on triangular wood slats, in a closed room having a temperature of 15°—20° C. (59°—68° F.).

In order to obtain uniform results when testing, the pressure must always be exerted on two sides of the cubes, but not on the bottom surface and the worked top surface.

The average from five specimens shall be considered as the standard compressive strength.

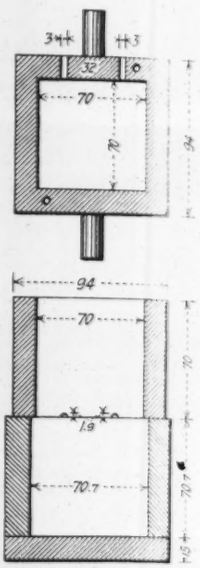

Fig. 2. Standard Mold for Compression Briquettes.
(Dimensions are in Millimeters.)

In regard to the testing apparatus suggested by the specification, it is recommended that only such apparatus and tools be used as are used by the Royal Institute for Testing Materials at Gross-Lichterfelde. This laboratory stands ready not only to perform the cement tests as specified officially but also will test for accuracy and standardization all cement-testing apparatus used by other laboratories.

In order to obtain concordant results, sand of equal size of grain and equal quality must always be used. The German standard sand is taken from the tertiary quartz layer of the brown coal formation in the neighborhood of Freienwalde a/Oder. The approximately white raw sand is cleaned in a washing machine and dried artificially. The sifting of the sand is done on swing-sieves suspended like a pendulum. One sieve is used for sifting off the coarse part while the other is used for the finer sand. From each day's output a sample is controlled as to size of grain and purity by the Royal Institute for Testing Materials.

For controlling the size of grain, sieves made of metal sheet, 0.25 mm. (0.01-in.) thick with circular holes 1.350 and 0.775 mm. (0.052 and 0.031 ins.) are made and used by the Association of German Portland Cement Manufacturers.

The standard sand found good after repeated tests is put in bags and sealed by the Royal Institute.

Iron Portland Cement.

There is also in Germany an Association of German Iron-Portland Cement Manufacturers, who make the so-called "Eisen-Portlandcement." This association has also promulgated specifications for its product. This specification is precisely the same as the one given above for Portland cement except in the first two sections which are changed as shown below:

I. DEFINITION.—Iron-Portland cement is a hydraulic compound which consists of at least 70% Portland cement clinker and, at the best, 30% granulated high furnace slag. The Portland cement is prepared according to the definition of the German Standard Specifica-

tions for Portland Cement. The furnace slags are lime-alumina-silicates.

They shall contain at least 1 part by weight of lime and magnesia to 1 part by weight of soluble silica ($Si\ O_2$) + alumina ($Al_2\ O_3$). The Portland cement and the slag must be ground finely. Additions for particular purposes, especially for regulating the time of setting, are admissible, limiting the amount, however, to 3% of the whole mass, in order to exclude the possibility of additions only for increasing the weight.

11. PACKING AND WEIGHT.—Iron-Portland cement is generally packed in bags or barrels. The package should show distinctly besides the gross weight and the term: "Iron-Portland cement," the name of the firm or the mark of the works as well as the brand of the association. Loss by sifting out as well as variations from the standard weight are admissible to the extent of 2%.

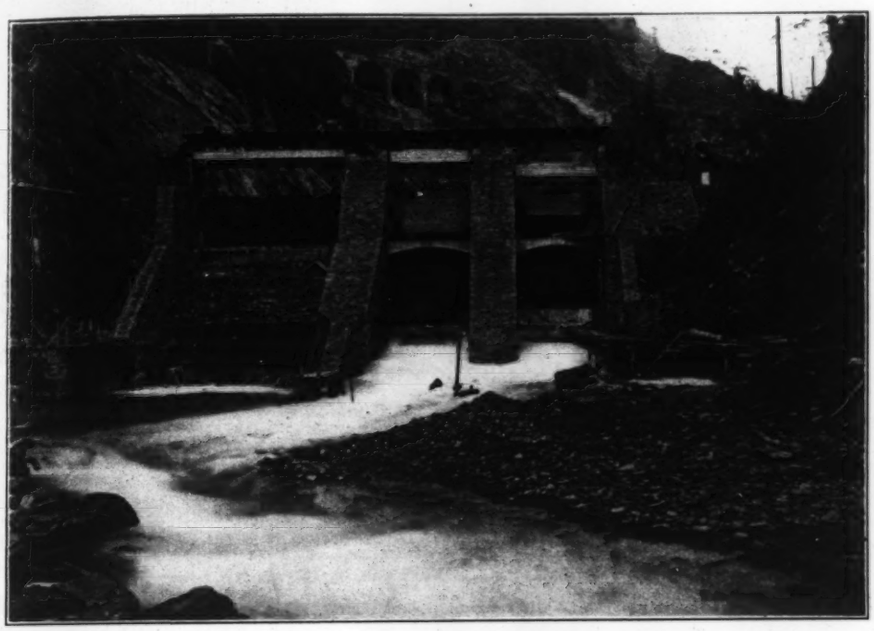

FIG. 1. STONEY-GATE DAM IN THE ALBULA RIVER; HYDRO-ELECTRIC PLANT OF THE CITY OF ZURICH, SWITZERLAND.
(View from down-stream side before completion.)

Stoney-Gate Dam in the Albula Canyon for the Hydro-Electric Power Plant of the City of Zurich, Switzerland.

By K. E. HILGARD,* M. Am. Soc. C. E.

The Stoney-gate dam, shown in Figs. 1 and 2 from the downstream and upstream sides, respectively, is situated near Solis, about nine kilometers above the confluence of the Albula and the Hinterrhein rivers at Thusis in the Canton des Grisons, Switzerland. In Fig. 1 on one side of the canyon, high above the river, can be seen a series of masonry arches and one of the many tunnels of the Raethian Ry.'s line from Thusis to the Engadine. The views were taken in November, 1909, that is about six weeks before the dam was entirely completed and put into service. This dam, at an elevation of 2,700 ft. above sea level, creates a storage pond nearly ¾ of a mile long and of sufficient capacity to fully equalize the maximum of all daily, or even weekly fluctuations in the consumption of water for power purposes, at the time of lowest flow in the river.

Lowest flow occurs generally in the months of January and February, when it drops to about 212 cu. ft. per sec. The water is backed up to a depth of 57.4 ft. above the former low water mark at the dam site, and 45.9 ft. above the sill of the two narrower gates. The maximum discharge of the Albula River may reach at times 10,600 cu. ft. per sec., and at such times it carries great quantities of debris and drift. The former, however, will not reach the dam, since it is now deposited far above and is decreasing annually in consequence of reforestation and consolidation of all ravines within the entire drainage area of the Albula.

*Consulting Engineer, Zurich, Switzerland.

General Description of the Plant.

At the intakes above the dam situated on the left side of the canyon, as will be seen from the plan in Fig. 4, the water enters two separate tunnels 21.3 ft. wide and of 377 sq. ft. cross-sectional area each, which serve as settling basins for the silt. Shortly below the lower ends of the settling basins the two corresponding branches of the supply tunnel unite into the regular oval cross-section with an area of 78.6 sq. ft. in the clear. From this point the water is carried in the tunnel all the way through slate rock for a distance of 4.57 miles to the surge-basin at the head of the penstocks. The available head there for the turbines averages about 492 ft. It is proposed to utilize as a maximum flow 565 cu. ft. per sec. Accordingly the power-house equipment comprises eight hydraulic units of 3,000-HP., double Francis wheels. These wheels are the first of the Francis type built and installed in Europe by Escher, Wyss & Co., for so great a head. From the transformers in the generating station, the alternating current at 40,000 volts is conducted by two separate transmission lines over a distance of 84.5 miles to the city of Zurich.

Stoney-Gate Dam.

The dam comprises three openings closed by three gates of the Stoney type. Its general arrangement and dimensions are shown in Fig. 3. The two sluiceway gates in the left half of the dam are alike, each being 26.25 ft. wide and 29.53 ft. high in the clear of the opening. The third, used as a flood gate, is 16.4 ft. high and 49.2 ft. wide in the clear of the opening. The construction of the two narrower gates is shown in Fig. 5, and the third gate is built quite similarly. As may be seen in the illustrations, the two scouring gates do not reach to within 16.4 ft. of the ordinary level of the storage pond. A bulkhead of reinforced concrete overtops these gates by this amount, so that the maximum pressure at their bottom on the gate-sill amounts to 45.93 ft. of water-column.

All three gates are counterbalanced by bars of solid concrete to the extent of about 70%. The weight of each of the high gates is 47 short tons, that of the low, wide gate is 36 short tons. These weights include the joint-tightening rods and the movable roller tracks, but not the roller trains, fixed tracks and gate-sills. Like the gates, the counterweights and counterbalanced roller trains are hung from steel cables, although link-chains—which are far more expensive, however, as they require very accurate shop work—are more commonly used for suspending gates and counterweights in modern Stoney gates.

The foundations of piers and abutments of the Albula dam consist of a series of massive concrete caissons, sunk to a depth of from 12 to 18 ft. below river bottom through debris to bed rock by the pneumatic process.

PROTECTION OF ROLLER MECHANISM FROM WATER WEAR.—The gates possess a somewhat novel feature. Cast-iron shields as shown in detail in Fig. 3 and marked with A and B, respectively, are attached on the up-stream and downstream sides over the lateral guiding grooves in piers and abutments; they protect the rolling tracks and roller trains from

FIG. 2. STONEY-GATE DAM IN THE ALBULA RIVER.
(View from up-stream side before completion.)

the action of the whirling water. The attachment of similar protecting-shields finally became necessary in the first dam of this kind designed for a heavily silt and debris-laden river by the late Mr. Stoney himself, viz., for the Stoney-gate dam in the River Rhone near Chèvres (Geneva, Switzerland), built in 1893-94. These shields were added there only a few years ago at a great cost to save the gates and rollers from further injury. They were suggested and designed by Mr. Saugey, C. E., Superintendent of the Chèvres plant.

In all ordinary Stoney-gates, when they are raised, the roller trains move over only half the distance through which the gates themselves move, and protrude below the lower edges of the gates within the guiding grooves of the piers or abutments. In turbulent and silt-bearing streams the whirling action of the water causes the lower disengaged rollers to revolve in their pin-bearings, and the protruding ends of the entire roller train to vibrate. Assisted by the grinding effect of silt, sand and debris carried in such water, this action causes the moving parts, as well as the roller track, to require extensive repairs in course of time.* It has been observed in some of the largest Swiss Stoney-gate dams,* that after a few years of service rollers were completely lost. In addition to the shields in the Albula dam, as a further precaution, the roller tracks, as is seen in Fig. 6, are arranged so that they can be easily replaced.

In the Albula dam the deep gates will rarely have to be opened, and the low gate at times can easily be made accessible. In other recently built or building Stoney-gate dams, where it is of more importance, provision has been made to eliminate the vibrations of the protruding ends of the roller trains or even the protrusion of the roller trains altogether. Nearly the same protection as the shields will afford is obtained by making the pier masonry on the upstream side of the gate project laterally in plan towards the opening beyond the downstream sides by the same amount that shield A (Fig. 3) projects beyond shield B. A valuable detail which could be adapted to serve the same end was introduced in the design of the Stoney gates of the controlling works of the Chicago Drainage Canal at Lockport, Ill. There, in any position of the gates when they are at rest, the roller trains are relieved from the pressure of the water and may be withdrawn for inspection or repairs.†

*At Hagneck and Beznau; for description see "The Design and Construction of Dams," by Ed. Wegmann, M. Am. Soc. C. E.; Wiley & Sons, New York. 1907; pp. 352-57 and plates EE, FF and No. C.

†For description see Eng. News, Dec. 12, 1895.

History and Costs.

The dam was started early in 1907 and was completed towards the end of 1909 at a cost of about $216,000. Its cost had been estimated in 1906 to be $163,000. The Stoney-gates were manufactured and erected by the firm of Löhle and Kern at Kloten (Zurich). The power plant

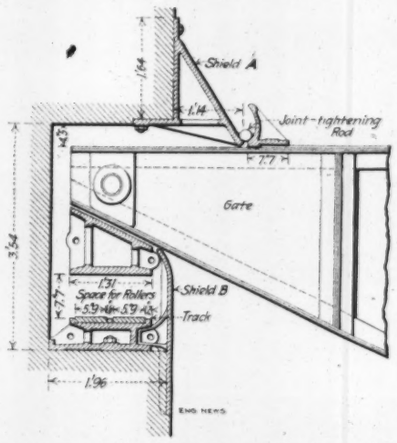

Fig. 3. Detail of Guiding Groove for Stoney-Gate, Albula Canyon Dam, Showing Shields for Protecting Roller Mechanism.

was put in service at the beginning of this year. The dam was designed in most of its parts, under able advice and assistance, by Mr. H. Peter, C. E., director of the water-supply department of the city of Zurich.

The cost of the 24,100 ft. of tunnel will amount to about $490,000, that of the penstocks to about $135,000; of the power-house, for the building, $108,000, for the hydraulic equipment about $94,000, and for the electric equipment about $131,000. The cost of the entire plant and all installations, including transmission lines to Zurich, will amount to about $2,400,000 as against the estimate (in 1906) of $2,085,000. The excess over the estimate is due to unforeseen difficulties in construction, labor and financial troubles of the principal contracting firm and to rises in wages and prices of material since 1906.

THE BANKERS' TRUST CO. BUILDING, which will replace the 16-story Gillender Building, recently torn down at the northwest corner of Wall and Nassau Sts., New York City, requires unusual foundation work, now in progress. The new building is to have 31 stories and a tower (407 ft. above curb). The level of groundwater at the site is about 17 ft. 10 ins. below curb level at the west building line. The plans call for three floors below curb level, in order to provide for the power plant and bank vaults of the institution. To make this possible the lot will be enclosed by 18 rectangular caissons sunk to bed rock, an elevation about 65 ft. below curb. Eight of these have already reached bed rock. They will be bonded together by concrete keypieces, completely forming the ring of caissons and providing for a waterproof interior. When the caisson cofferdam is thus complete, the interior will be excavated, and the three 12 × 70-ft. caissons which carried the Gillender Building will be left exposed. These will then be blasted out and removed. The 27 interior column footings of the new building rest on rock. The work is being carried out by the Foundation Company of New York, who have also executed the underpinning of the 8-story building adjoining on the west.

A BUTTING COLLISION between a light engine and a freight train on the Central Vermont R. R. at Northfield Falls, Vt., Aug. 21, wrecked both locomotives and eight cars. The wreckage caught fire and two tank cars exploded. Seven trainmen were killed.

THE SPANISH STEAMER "MARTOS" was sunk Aug. 16 off Tarifa Point at the entrance to the Straits of Gibraltar. The ship sank a few minutes after a collision with the German steamship "Elsa" in a dense fog. Seven of the crew of the "Martos" and 32 of her passengers were drowned.

A BOILER EXPLOSION AT SEA Aug. 13 wrecked the steam schooner "Phoenix" about ten miles north of the Point Arena, Cal., lighthouse. Four men were killed and three others injured. The "Phoenix" was loaded with bark, and on the day following the accident, she was still floating, bottom up.

A GASOLINE FERRYBOAT EXPLOSION Aug. 17 killed six persons and injured four others on the trip between St. Georges and Sandy Point, Newfoundland. The upper deck of the boat, according to reports, was torn to pieces and several passengers besides those hurt were thrown into the water. The boat was a new one and had been on the route only two months.

FOREST FIRES IN IDAHO AND MONTANA are still spreading and press reports of Aug. 23 state that nearly the whole panhandle of Idaho is on fire. Idaho and Montana militia have been ordered out to assist the Forest Service rangers and the United States troops in fighting the flames. One-half of the town of Wallace, Idaho, was destroyed Aug. 21, and on the same date the town of Taft, Mont., was entirely consumed. It is reported that 24 persons lost their lives in the fire at Wallace. The Iron Mountain Tunnel Co.'s mining property near Iron Mountain, Mont., was destroyed completely Aug. 22. The heaviest loss in timber is in the national forest reservations.

A CONFLAGRATION IN JERSEY CITY on the evening of Aug. 18 destroyed every building in the block bounded by Washington, Warren, Steuben and Morgan Sts., which lies about 150 ft. west from the Pennsylvania R. R. station. Among the buildings destroyed

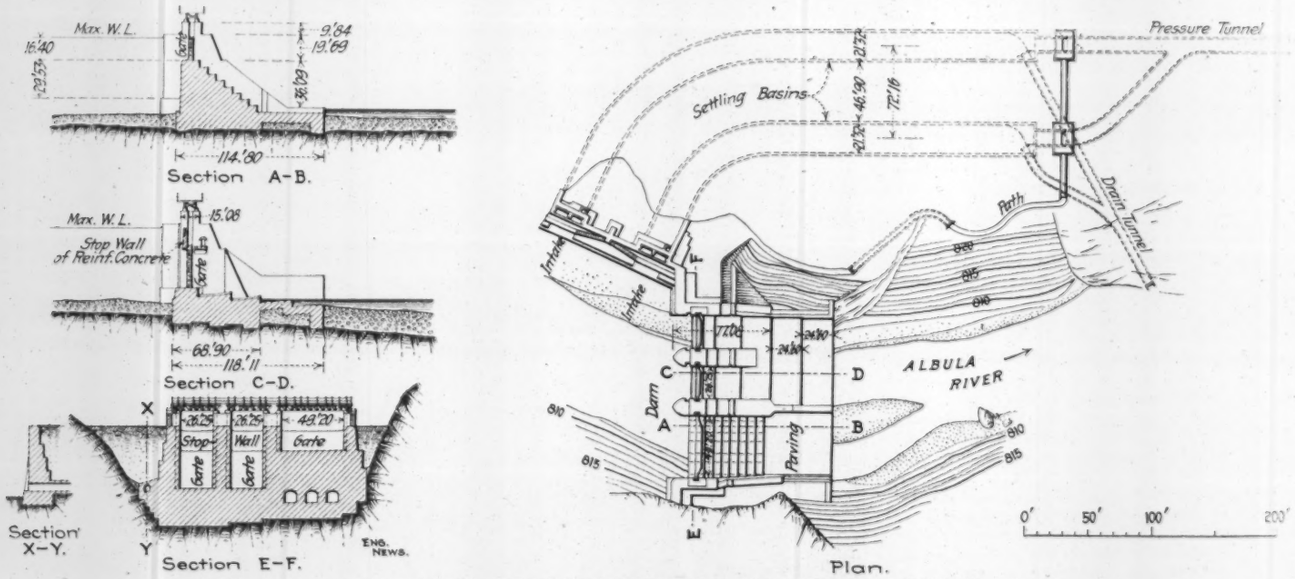

FIG. 4. PLAN AND SECTIONAL ELEVATIONS OF ALBULA CANYON DAM.

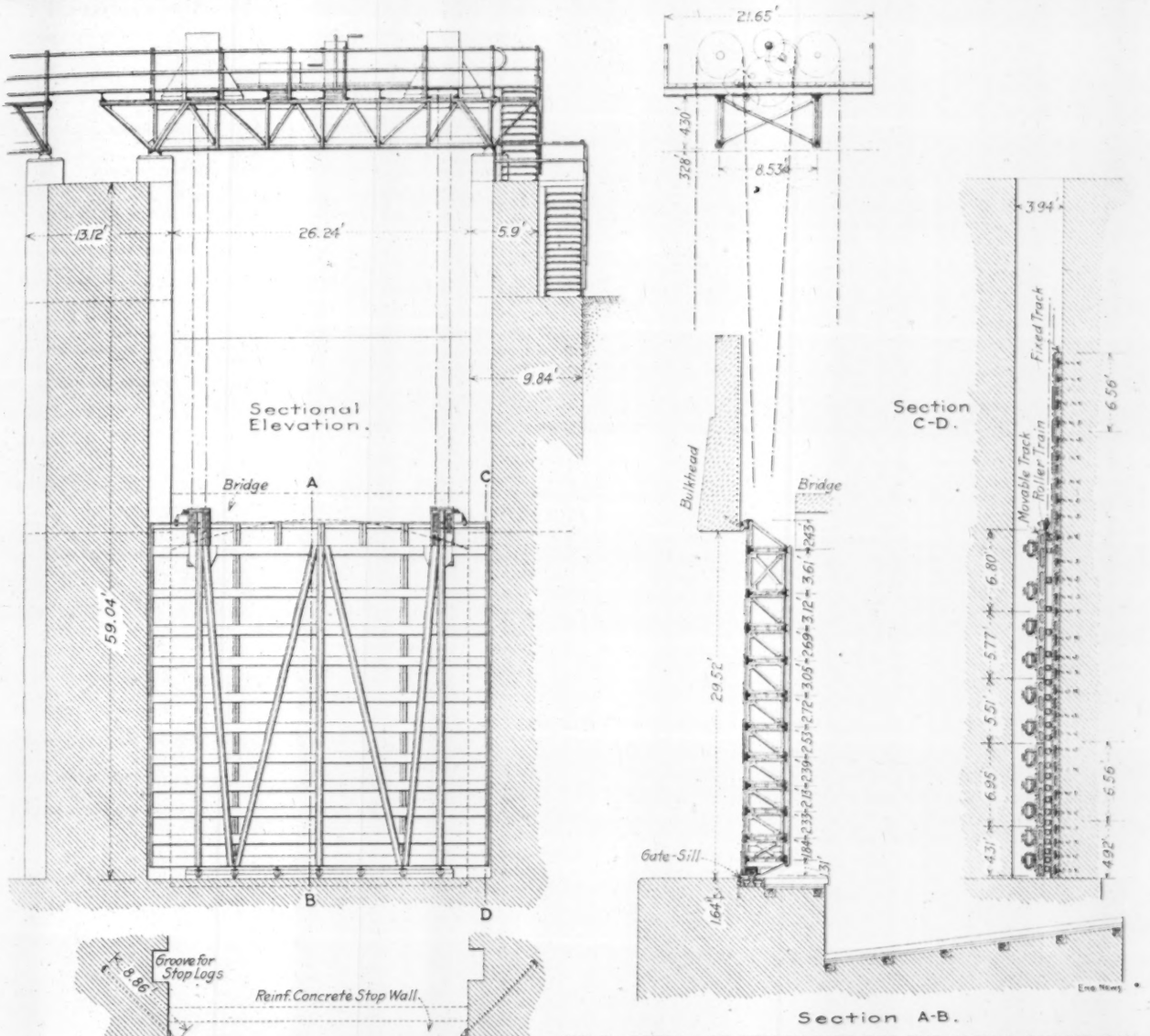

FIG. 5. DETAILS OF STONEY-GATE FOR THE ALBULA CANYON DAM.

were the cork factory of the Truslow & Tulle Co., the rolling mill of the Ames Spike Co. and the plant of the Regal Sack Co. The loss is estimated at $1,000,000.

THE BRITISH CRUISER "BEDFORD" ran ashore Aug. 21 on the rocks off Quelport Island, Corea. Eighteen men of the engine room staff were killed. The accident occurred at an early hour in the morning during a heavy fog. According to press reports there is but little possibility that the vessel can be floated. The "Bedford" is 440 ft. long and has a displacement of 9,800 tons. Her rated speed is almost 23 knots. She was armed with 14 6-in. guns and carried a normal complement of 537 men.

BY A FALL from a Farman biplane flyer, Lieut. Vivaldi, of the Italian Army, was killed near Rome, Aug. 20. The victim had but recently taken up aviation and was flying at a height of about 1,000 ft. when the trouble with his machine occurred.

A FLIGHT FROM PARIS TO LONDON was attempted on Aug. 17 by John B. Moissan, of Chicago, in a monoplane flyer with one passenger. His first stop was at Amiens, where he remained over night. The second stop was at Calais, where he secured a vessel to attend him across the Channel. The British coast was passed at Deal, some eight miles from Dover and a stop was made at Tilmanstone, seven miles inland. The next day, Aug. 20, he attempted to reach London but was forced to descend at Upchurch. Two attempts were made on Aug. 22 but only a few miles were gained and the machine was badly damaged in a descent at Sevenoaks, 20 miles from London.

THE ARMORED CRUISER "LION" of the British Navy, which was launched from Devonport dockyard on Saturday, Aug. 6, represents as important a departure in naval construction as has appeared since the "Dreadnought" type of battleship. The "Lion" will far surpass in speed every cruiser in the world's navies and every merchant vessel afloat. Even the far-famed "Lusitania" and "Mauretania" would be easily overtaken by the "Lion." She combines with this speed a battery which is claimed to exceed in destructive power that of any battleship yet built, and an armor belt 9 ins. in thickness. This remarkable combination of speed, fighting power and defensive armor has been made possible by giving the hull of the vessel dimensions far in excess of any naval vessel hitherto constructed. The "Lion" is 700 ft. long over all, 680 ft. long between perpendiculars; has a beam of 88½ ft. and a total displacement of 26,350 tons. She will be propelled by the largest Parsons marine steam turbines ever built, developing a total of 70,000 HP. and taking steam from 42 water-tube boilers. It is calculated that this power will give the vessel a sustained sea speed of 28 knots; but in view of her great length and fine lines at bow and stern, it is claimed that this figure may be considerably exceeded, and that as high as 30 knots may be reached on the measured mile.

The "Lion" is to carry an armament of eight heavy guns, each of 13.5-in. caliber, firing a projectile weighing 1,250 lbs., capable of penetrating 22 ins. of armor at a range of 5,000 yds. The total weight of armor carried is not made public, but its thickness of 9 ins. amidships is in excess of the armor of any British cruiser.

How great a departure the "Lion" represents from previous British cruisers in point of size is shown by the following table, which we reprint from the London "Telegraph" of Aug. 6.:

Class.*	Displacement, tons.	Length, ft.	Beam, ft.
Monmouth (10)	9,800	440	66
Devonshire (6)	18,850	450	68½
Duke of Edinburgh (6)	13,550	480	73½
Minotaur (3)	14,600	490	74½
Invincible (3)	17,250	530	78½
Indefatigable (1)	18,750	555	80
Lion (2)	26,350	660	88½

*The number in parenthesis gives the number of cruisers built of each class.

The "Lion" is expected to be completed and ready for service by November, 1911. A sistership, the "Princess Royal" is being built at Barrow.

AN INSPECTION OF BRICK PAVEMENTS in cities of the Central West was made recently by a party of engineers. The party included members of the committee on standard street paving specifications appointed some time ago by the American Society of Municipal Improvements, and also members of a committee representing the Organization of City Officials for Standardizing Paving Specifications, the latter committee having been appointed for the special purpose of recom-

mending standard specifications for vitrified pavements. The trip was made under the auspices of the National Paving Brick Manufacturers' Association, but the inspections themselves were directed by the city engineers of the several cities visited. At Indianapolis the engineers inspected the 2½-mile motor speedway which is paved with vitrified brick filled with cement. Visits were also made to Terre Haute, Ind., where brick pavements have been in use for 20 years, and Cincinnati, Columbus and Cleveland. Members of the party were as follows:

C. H. Rust, Toronto, Canada, E. A. Fisher, Rochester, N. Y., and Charles C. Brown, Indianapolis, from the committee of the American Society of Municipal Improvements; Edward H. Christ, of Grand Rapids, D. M. Roberts of Terre Haute, John B. Hittell, of Chicago, and Henry Maetzel of Columbus, Ohio, representing the committee from the Organization of City Officials for Standardizing Specifications. Others in the party were H. W. Klausmann, city engineer of Indianapolis, Professor Ira O. Baker, dean of the civil engineering school, Ohio State University, Professor F. H. Eno, professor of municipal engineering, Ohio State University, Will P. Blair, secretary of the National Paving Brick Manufacturers Association, Indianapolis. We are indebted to Merle Sidener of the Indianapolis Commercial Club for the foregoing information.

WEEKLY WAGES AND HOURS OF LABOR IN Leeds, England, during 1909 are reported in a recent issue of U. S. Consular Reports. We give the figures of most interest to engineers as follows:

Trade.	Wages.	Hours.
Boiler makers:		
Angle smiths	$10.46	53
Holders up	7.30	53
Platers	9.49	53
Riveters	8.51	53
Brass molders	8.51	53
Brass finishers	8.27	53
Bricklayers	9.53	49½
Electrical workers	8.76	54
Engineers [Machinists?]	8.27	53
Iron founders	9.49	53
Joiners	9.03	49½
Pattern makers	9.25	53
Plasterers	9.53	49½
Plasterers' laborers	7.02	49½
Plumbers	9.03	49½
Polishers	8.51	52½
Railway draymen	*4.87	58
Sheet-metal workers	7.54	53
Shoeing smiths	*7.30	54
Slaters and tilers	9.13	50
Smiths	8.51	53
Smiths' strikers	5.59	53
Steam-engine makers	*8.27	53
Street masons and pavers	9.13	50
Telephone wire men	*5.83	52½
Train drivers and conductors	*† .10	60
Wheelwrights	*6.32	53

*Minimum. †Per hour.

These figures may be compared, by those interested, with somewhat similar figures for New York City, given in our Current Prices Supplement for Aug. 4.

METHODS OF SAFEGUARDING AN IRRIGATION Canal installed by the U. S. Reclamation Service are described in the following official statement:

The engineers in charge of the Tieton unit of the Yakima irrigation project, Washington, are making some interesting experiments in connection with the operation of the main canal. The upper twelve miles of this canal are along the steep hillsides, in fact along canyon walls. On June 19 a three-ton boulder rolled into the canal from a height of 200 ft., breaking two concrete shapes and blocking up the channel. Luckily there was but a small flow of water in the canal at the time and no serious damage resulted. With the canal running full, carrying about 300 sec. ft., such a boulder would at once throw the water out of the canal and down the hillside, causing great damage until the water could be turned off and the break repaired. This has been foreseen practically from the commencement of construction and wasteways have been installed every two miles for the purpose of taking care of the entire flow of the canal should such a catastrophe occur. These wasteways are expensive and their installation has been severely criticised. In addition to the wasteways a system of electric control has now been designed which will open the wastegates should the water rise above a certain point in the canal, or should it drop below a certain given minimum. Experiments are being made to provide for the best floats or other apparatus to indicate such a variation in the flow of water either up or down, as would indicate danger. This apparatus will be connected with the electrical control system and will be the means by which the waste gates are opened.

A FRANCHISE FOR A BRINE DISTRIBUTING system in certain limited districts of New York City was applied for early in the present year by the Merchants Refrigerating Co. The form of franchise recently recommended by the Division of Franchises of the Board of Estimate and Apportionment includes the following principal requirements:

The company shall be required to extend its system to the premises of any applicants located within either of the smaller districts and furnish refrigeration thereto. If either of these districts be extended, the same obligation to attach to the additional territory. On account of the impracticability of pumping the brine above the first floor of buildings located at a distance from the company's plants, this compulsory service has been restricted to the first or ground floor.

The schedule of rates which the company may charge for service is as follows:

Consumers making monthly contracts, 4 cts. per month per cu. ft. for boxes of not over 500 cu. ft.; 2 cts. per month per cu. ft. for boxes of 500 to 1,500 cu. ft. and 1 ct. per month per cu. ft. for boxes of 1,500 cu. ft. and over. Consumers making yearly contracts, 15 cts. per year per cu. ft. of box.

Compensation to be paid by the company to the city for the proposed grant is suggested as follows:

Initial payment, $2,000. The payment, within 30 days from the date on which this contract is signed by the Mayor, of the sum of $2,500, which is due the city by reason of the past use and occupation of the streets. Annual payments: During the first five years, 2% of the gross receipts, which percentage shall not be less than $800. During the second five years, 3% of the gross receipts, which percentage shall not be less than $1,200. During the third five years, 3% of the gross receipts, which percentage shall not be less than $1,500. Twenty-five cents per linear foot of conduit and $2 for each manhole constructed within the limits of the streets.

Previous grants, of a similar nature to the one proposed, have been made to the Seaboard Refrigeration Co., the Kings County Refrigerating Co., and the Harrison Street Cold Storage Co.

EXPORTS OF IRON AND STEEL manufactures from the United States in the past 15 years exceeded in value the corresponding imports by 1,400 million dollars. In the 15 years immediately preceding, on the other hand, imports exceeded exports by 300 million dollars. According to the following figures published by the Bureau of Statistics of the Department of Commerce and Labor, the excess in value of exports over imports of iron and steel manufactures in the last ten years is more than 2½ times the excess of imports over exports in the preceding 40 years:

Iron and steel manufactures.	40 years, 1861-1900.	10 years, 1900-'10.
Imports	$1,409,000,000	$307,000,000
Exports	973,000,000	1,411,000,000
Difference	436,000,000	1,104,000,000

Personals.

Mr. C. W. Staniford, M. Am. Soc. C. E., Chief Engineer of the Department of Docks and Ferries of New York City, sailed Aug. 2 for Liverpool, Eng., on the steamship "Carmania." He will visit various European ports with the idea of gaining information to be applied in improving the Port of New York.

Mr. J. N. Chester, formerly Chief Engineer of the American Water Works & Guarantee Co., and Mr. Thomas Fleming, Jr., formerly Principal Assistant Engineer in charge of the design and construction section of the Pennsylvania State Department of Health, have formed a partnership as consulting engineers with offices in the Union Bank Bldg., Pittsburg, Pa.

Capt. J. H. Linnard, U. S. N., senior officer of the Corps of Naval Constructors, has been retired, on his own application, under the 30-year service law. He was appointed a cadet midshipman in June, 1877. Since 1901 he has been on duty in the Bureau of Construction and Repair as Senior Assistant to the Chief Constructor. He has served during part of this same period as Superintending Constructor of naval vessels under construction at the works of the New York Shipbuilding Co., and other private shipyards. He was also General Inspector of all work under the cognizance of the Bureau of Construction and Repair.

Obituary.

George F. Folsom, formerly Superintendent of Construction of the Boston & Providence R. R., from which position he retired in 1888, died Aug. 19 at the home of his daughter in Roslindale, a suburb of Boston, Mass., at the age of 80 years.

Engineering Societies.

COMING MEETINGS.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 5-9. Annual meeting at Milwaukee, Wis. Secy., W. C. Woodward, Washington, D. C.

NATIONAL CONSERVATION CONGRESS.
Sept. 5-9. Second annual meeting at St. Paul, Minn. Secy., Thomas R. Shipp, St. Paul, Minn.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 6-8. Annual meeting at Thousand Islands, N. Y. Asst. Secy., Walter Neumuller, 55 Duane St., New York City.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 6-9. Annual convention at Rochester, N. Y. Secy., Frank P. Foster, Corning, N. Y.

MICHIGAN GAS ASSOCIATION.
Sept. 8-12. Annual meeting on board steamer sailing from Detroit, Mich. Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 13-16. Annual convention at St. Louis, Mo. Secy., A. P. Dane, Reading, Mass.

ROADMASTERS AND MAINTENANCE-OF-WAY ASSOCIATION.
Sept. 13-16. Annual convention at Chicago, Ill. Walter E. Emery, Chief Engineer, Peoria & Union Ry., Peoria, Ill.

COLORADO ELECTRIC LIGHT, POWER AND WAY ASSOCIATION.
Sept. 21-23. Annual convention at Colorado Secy., J. C. Lawler, P. O. Box 938, Colorado

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 21-23. Annual convention at Rochester. Secy., Willard Kent, Narragansett Pier, R. I.

NATIONAL IRRIGATION CONGRESS.
Sept. 26-30. Annual meeting at Pueblo, Colo. Arthur Hooker, Pueblo, Colo.

AMERICAN STREET & INTERURBAN RAILWAY ASSOCIATION.
Oct. 10-14. Annual convention at Atlantic City. Secy., H. C. Donecker, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 11-14. Annual convention at Erie, Pa. Secy. P. Folwell, 239 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 11-13. Annual meeting at Richmond, Va. Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN ELECTROCHEMICAL SOCIETY.
Oct. 13-15. Annual meeting at Chicago, Ill. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION.
Oct. 18-20. Annual convention at Fort Worth, Tex. Secy., C. A. Lichty, Chicago & Northwestern Ry., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 19-21. Annual meeting at New York City. Secy., A. B. Beadle, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 21-Nov. 15. Canal Zone meeting. Secy., R. W. Raymond, 29 West 39th St., New York City.

ILLUMINATING ENGINEERING SOCIETY.
Oct. 24. Annual meeting at Baltimore, Md. Secy., P. S. Millar, 29 West 39th St., New York City.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.—Papers to be presented at the 15th annual convention in Rochester, N. Y., Sept. 6-9, are announced as follows: "Wireless Telephone and Telegraph," John W. Kelly, Jr., Camden, N. J.; "Lightning Protection," Walter M. Petty, Rutherford, N. J.; "Mercury Arc and Other Rectifiers," H. G. Kennedy, Rochester, N. Y.; "Relation of the Telephone to the General Organization of Fire Department Service," H. C. Bundy, Watertown, N. Y.; "Underground Work," J. B. Yeakle, Baltimore, Md., and C. R. George, Houston, Tex.; "Modern Police Signal System," J. B. Smith, Rochester, N. Y.; "City and National Code Rules, and the Relation Between the City and the Underwriters' Inspectors," R. A. Smith, Norfolk, Va.; "Inductive Loads With Low Power Factors," A. S. Hatch, Detroit, Mich.

INTERNATIONAL CONGRESS OF REFRIGERATION.—The second meeting is to be held at Vienna, Austria, Oct. 6-12. The program is divided among six commissions under the following heads: (1) Gases and units; (2) Construction and testing of refrigerating machinery and insulating materials. (3) Application of refrigeration to food. (4) Industrial refrigeration. (5) Railway and steamship refrigeration. (6) Legislation and administration. Membership in the American Association of Refrigeration, annual dues $10, entitles one to attend the international congress and to copies of its papers and reports, published in English. The secretary of the American association is Mr. J. F. Nickerson, 315 Dearborn St., Chicago, Ill.

A joint resolution authorizing President Taft to invite the International Congress of Refrigeration to hold its third meeting in the United States, was passed by both houses of the National Legislature just before their recent adjournment.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.—At the annual convention to be held at St. Louis, Mo., Sept. 13-16, papers will be presented on "Quality Versus Quantity in Shop Output," by Charles A. Cook, Philadelphia, Baltimore & Washington Ry.; on "Inert Pigments, Their Use and Abuse," by Anderson Polk, Lowe Bros. Co., and on "An Ideal Railway Car Paint Shop," by W. O. Quest, Pittsburg & Lake Erie R. R. The following "queries" will be discussed: (1) Is it economy to keep a practical painter in round houses to look after things generally? (2) Considering the health of the workman, should we not seek a suitable substitute for white lead for interior painting? (3) What is the best method of treating structural aluminum on interiors of steel passenger cars? (4) Rushing cars through the shops for paint and varnish, and the resulting claims for damages by passengers for soiled clothing and shoes: What remedies?

Other subjects to be discussed are the use of oil or emulsion cleaners for exterior varnished surfaces, the possibility of overcoming the difficulty due to the action of steam heat in passenger coaches on the glue used in holding veneer, organization of the paint shop force on a piece-work basis, and the painting and maintenance of canvas roofs.